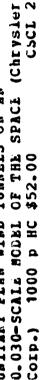
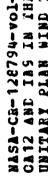
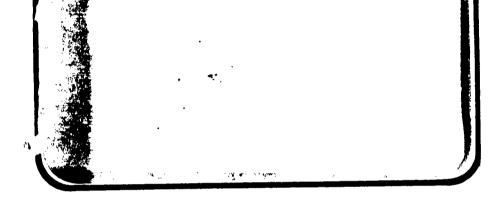
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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE

AEROTHERMODYNAMIC DATA REPORT

HOUSTON, TEXAS

JOHNSON SPACE CENTER

DATA MANagement services

DMS-DR-2032 NASA CR-128,794

VOLUME 5 of 18

RESULTS OF TESTS OAL2 AND IA9 IN THE

AMES RESEARCH CENTER UNITARY PLAN WIND TUNNELS

ON AN 0.030-SCALE MODEL OF THE SPACE SHUTTLE

VEHICLE 2A TO DETERMINE AERODYNAMIC LOADS

Ву

R. H. Spangler Rockwell International

Prepared under NASA Contract Number NAS9-13247

By

Data Management Services
Chrysler Corporation Space Division
New Orleans, Louisiana 70189

for

Engineering Analysis Division

Johnson Space Center National Aeronautics and Space Administration Houston, Texas

WING TUNNEL TEST SPECIFICS:

Test Numbers:

ARC 11-707 (A) ARC 97-707 (B) ARC 87-707 (C)

NASA Series Numbers:

IA9A, B, C and OA12A, C

Test Date:

2 April - 17 May, 1973

FACILITY COORDINATOR:

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This document has been reviewed and is approved for release.

FOR N. D. Kemp

Data Management Services

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AMES RESEARCH CENTER UNITARY PLAN WIND TUNNELS

ON AN 0.030-SCALE MODEL OF THE SPACE SHUTTLE

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By

R. H. Spangler Rockwell International

ABSTRACT

Tests were conducted in the NASA/ARC Unitary Plan Wind Tunnels during April and May 1973, on an 0.030-scale replica of the Space Shuttle Vehicle Configuration 2A. Aerodynamic loads data were obtained at Mach numbers from 0.6 to 3.5.

The investigation included Tests IA9A, B and C on the invegrated (launch) configuration and Tests OA12A and C on the isolated orbiter (entry configuration). The integrated vehicle was tested at angles of attack and sideslip from -8 degrees to +8 degrees. The isolated orbiter was tested at angles of attack from -15 degrees to +40 degrees and angles of sideslip from -10 degrees to +10 degrees as dictated by trajectory considerations. The effects of orbiter/external tank incidence angle and deflected control surfaces on aerodynamic loads were also investigated.

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Implitudinal madring of Orbiter Fuselage Pressures		0.5	Ą	0	0		25-54
		-1.2	¥	0	0	-	£18
		0.5	ထု	闰	0	PHI, MACH, BETA	79-102
		0.5	4	闰	0		103-126
		0.5	0	闰	0		127-156
		0.5	4	闰	0		157-180
		0.5	æ	闰	0		181-20 ⁴
		0.5	0	国	-5		205-216
		0.5	0	闰	-10		217-228
>	-	0.5	0	戶	-15	B ireto	229-540
• I construction of Distribution of	CP vs X/III	1.5	4	0	0	PHI, MACH, ALPHA	241-264
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	->	-1.2	Ą	0	0		295-318
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External Tank Pressures	· · · · · · · · · · · · · · · · · · ·	0.5	7	岡	0		343-366
		0.5	0	떰	0		367-396
		0.5	4	阿	0		397-420
	-	0.5	ω	阿	0	~	444-124
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SRM Booster Pressures		0.5	Ą	0	0		084-194
		-1.2	¥	0	0	->	964-184
		0.5	ထု	덛	0	PHI, MACH, BETA	497-512
		0.5	7	闰	0		513-528
	,	0.5	0	闰	0		529-548
		0.5	4	闰	0	· • • • • • • • • • • • • • • • • • • •	495-645
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		0.5	4	Þ	0		685-700
	->	0.5	ω	闰	0	~	701-716
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		0.5	4	臼	0		789-804
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		0.5	&	闰	₹		837-844
		0.5	ထု	闰	-10		845-852
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SPM Booster Base Pressures	CP vs ALPHA	0.5	A	0	0	HI, MACH, X/LS	933-937
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Orbiter Fuselage Pressures		0.5	7	н	0		79-6t
		0.5	æ	н	0		61-7 2
		0,5	0	ভ	-15		73-84
		0.5	0	ធ	-10		85-96
-	> -	0.5	0	M	15	-	97-108
i Tomest sudding i Misteribution of	CP vo X/LT	0.5	ત	0	0	THI, MACH, ALPHA	109-150
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SRM Booster Pressures	-	0.5	ထု	н	0	PHI, MACH, BETA	221-228
rhordwise Distribution of	CP VS X/CW	0.5	Ą	0	0	Y/BW, MACH, ALPHA	229-536
Upper and Lower Surface Wing Pressures		0.5	æ	H	0	Y/BW, MACH, BETA	237-244
		0.5	4	н	0		245-252
		0.5	0	H	0		253-260
		0.5	4	н	0		261-268
•		0.5	ထု	н	0	*	569-276
dulse Distribution of	CP vs X/CV	0.5	¥	0	0	Z/BV, MACH, ALPHA	1 2TT-284
Left and Right Surface		0.5	ω	н	0	Z/BV, MACH, BETA	285-292
	•	0.5	4	н	0	,	293-300
		0.5	0	н	0	4.00	301-308
		0.5	4	н	0		309-316
		0.5	ထု	н	0		317-324
	· · · · · ·	0.5	ထု	闰	-15		325-332
	-	0.5	0	回	-15	-	333−3‡0

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Left and Right Surface Vertical Tail Pressures		0.5	ထု	闰	-10		349-356
	·	0.5	0	চ্য	-10		357-364
		0.5	ω	闰	-10		365-372
	·	0.5	ထု	闰	15		373-380
		0.5	0	闽	15		381-388
	-	0.5	ø	闽	15		389-396
orbiter Base Pressures	CP vs ALPHA	0.5	А	0	0	MACH, ALPHA	397-400
Orbiter Base Pressures	CP vs BETA	0.5	0	ರ	0	MACH, BETA	404-104
Upper MPS Nozzle Pressures	CP vs ALPHA	0.5	m	0	0	PHI, MACH, X/LMP	904-504
Upper MPS Nozzle Pressures	CP vs BETA	0.5	0	Ġ	0	PHI, MACH, X/LMP	407-TO4
OMS Nozzle Pressures	CP VS ALPHA	0.5	Д	0	0	PHI, MACH, X/LAW	014-604
OMS Nozzle Pressures	CP vs BETA	0.5	0	ರ	0	PHI, MACH, X/LIW	411-415
SRM Booster Base Pressures	CP vs ALPHA	0.5	A	0	0	PHI, MACH, X/LS	413-414
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		0.5	7	Þ	0		424-45 4
		0.5	0	M	0		742-495
		0.5	4	μ	0		493-510
		0.5	Φ	M	0		511-528
		0.5	0	ម	-15		9 1 5-625
		0.5	0	M	-10		547-564
I condition Distribution of	CP VS X/LT	0.5	A	0	0	PHI, MACH, ALPHA	565-585
External Tank Pressures		۰. د	ထု	চ্য	0	PHI, MACH, PETA	583-600
		0.5	7	M	0	- · · · ·	601-618
		0.5	0	P	0		619-636
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SRM Booster Pressures		0.5	ထု	闰	0	PHI, MACH, BETA	969-589
		0.5	4-	田	0		697-708
	-	0.5	0	闰	0		709-720
		0.5	4	Ħ	0		721-732
->-		0.5	æ	闰	0	.)	733-7 ⁴⁴
Chordwise Distribution of	CP vs X/CW	0.5	A	0	0	Y/BW, MACH, ALPHA	745-756
Upper and Lower Surface Wing Pressures		0.5	ထု	闰	0	Y/BW, MACH, BETA	151-767
		0.5	7	闰	0		768-780
		0.5	0	Ħ	0		781-792
		0.5	4	闰	0		793-804
	-	0.5	ω	闰	0	-	805-816
Chordwise Distribution of	CP vs X/CV	0.5	Ą	0	0	Z/BV, MACH, ALPHA	817-828
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		0.5	4	闰	0		841-852
		0.5	0	曰	0		853-864
	-	0.5	4	闰	0		865-876

		Þ				1	
	TYPE OF		RAME	PARAMETERS		CONDITIONS	700
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Chordwise Distribution of	CP vs X/CV	0.5	8	闰	0	Z/BV, MACH, BETA	877-888
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		0.5	0	闰	-15		901-915
		0.5	80	闰	-15		913-924
	<u> </u>	0.5	ထု	M	-10		925-936
		0.5	0	闰	-10		937-948
••••	-> -	0.5	8	闁	-10		096-646
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Test OA12A	CP VS X/LB	ບ	0	0	0	0	PHI, MACH, ALPHA	1-24
		0	دا	0	0	0	PHI, MACH, BETA	25-36
		10	د	0	0	0		37-48
		20	. 5	0	0	0		09-64
		0	×	0	-10	0		61-78
		0	M	0	-50	0		96-62
		0	H	70	0	0		97-108
		0	×	-10	0	0		109-126
		0	×	-20	0	0		127-144
-	-	0	M	0	0	70	-	145-162
A straight of or	CP vs X/CW	ບ	0	0	0	0	Y/BW, MACH, ALPHA	163-178
Upper and Lower Surface Wing		0	כו	0	0	0	Y/BW, MACH, BETA	179-186
		10	ى	0	0	0		187-19 ⁴
		80	دا	0	0	0		195-202
>	-3 -	0	Н	10	0	0	->-	203-210

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Upper and Lower Surface Wing Pressures		8	н	91	0	0			219-226
		0	×	-10	0	0			227-238
	1 1	70	×	-10	0	0			239-250
		80	M	-10	0	0			251-262
	•	0	M	-50	0	0			263-274
		2	M	- 50	0	0	<u>. </u>		275-286
		8	M	-50	0	0			287-298
Chordwise Distribution of	CP VB X/CV	ပ	0	0	0	0	Z/BV, MACH, ALPHA	LPHA	299-314
Left and Right Surface Vertical Tail Pressures		0	h	0	0	0	Z/BV, MACH, B	BETA	315-322
		10	r	0	0	0			323-330
		8	دا	0	0	0	 		331-338
		0	×	0	-10	0			339-350
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20 K 0 -20 0 10 10 10 10 10 10 10		CP vs X/CV	10	×	0	8	0	MACH,	387-398
10 K 0 0 40 10 10 10 10 10 10	Left and Right Surface Vertical Tail Pressures		20	M	0	-20	0		399-410
CP vs ALPHA C 0 0 40 MACH, ALPHA CP vs BETA C 0 0 0 0 MACH, BETA CP vs BETA C 0 0 0 0 PHI, MACH, X/LMP CP vs BETA C 0 0 0 PHI, MACH, X/LMP CP vs BETA C 0 0 0 PHI, MACH, X/LMP CP vs BETA C 0 0 0 PHI, MACH, X/LMP CP vs BETA C 0 0 0 PHI, MACH, X/LMP CP vs BETA C 0 0 0 PHI, MACH, X/LMP CP vs BETA C 0 0 0 PHI, MACH, X/LMP CP vs BETA C 0 0 0 PHI, MACH, X/LMP CP vs BETA C 0 0 0 PHI, MACH, X/LMP CP vs BETA C 0 0 0 PHI, MACH, X/LMP CP vs BETA C 0 0 0 PHI, MACH, BETA CP vs BETA C 0 0 0 0 PHI, MACH, BETA CP vs BETA C 0 0 0 0 PHI, MACH, BETA CP vs BETA C 0 0 0 0 0 PHI, MACH, BETA CP vs BETA C 0 0 0 0 0 PHI, MACH, BETA CP vs BETA C 0 0 0 0 0 PHI, MACH, BETA	-		0	×	0	0	04		411-422
CP VS ALPHA C 0 0 0 0 MACH, ALPHA CP VS BETA C 0 0 0 0 MACH, BETA CP VS BETA C 0 0 0 0 PHI, MACH, X/LMP CP VS ALPHA C 0 0 0 0 PHI, MACH, X/LMP CP VS ALPHA C 0 0 0 0 PHI, MACH, X/LMP CP VS ALPHA C 0 0 0 0 PHI, MACH, X/LMP CP VS ALPHA C 0 0 0 0 PHI, MACH, X/LMP CP VS ALPHA C 0 0 0 0 PHI, MACH, X/LMP CP VS ALPHA C 0 0 0 0 PHI, MACH, X/LMP CP VS ALPHA C 0 0 0 0 PHI, MACH, X/LMP CP VS ALPHA C 0 0 0 0 PHI, MACH, ALPHA OF CP VS X/LB D 0 0 0 0 PHI, MACH, BETA O M 0 -20 h0 PHI, MACH, BETA 20 M 0 -20 h0		·	10	M	0	0	04	- 12	423-434
CP vs ALPHA C O O O O MACH, ALPHA CP vs BETA O J O O O PHI, MACH, X/LMP CP vs BETA O J O O PHI, MACH, X/LMP CP vs BETA O J O O PHI, MACH, X/LMP CP vs BETA O J O O PHI, MACH, X/LMP CP vs BETA O J O O PHI, MACH, X/LMP CP vs BETA O J O O O PHI, MACH, X/LMP CP vs BETA O J O O O PHI, MACH, X/LMP CP vs BETA O J O O O PHI, MACH, X/LMP CP vs BETA O J O O O PHI, MACH, X/LMP CP vs BETA O J O O O PHI, MACH, X/LMP CP vs BETA O J O O O O PHI, MACH, X/LMP CP vs BETA O O O O O O PHI, MACH, BETA CP vs BETA O O O O O O O O PHI, MACH, BETA			20	M	0	0	04	*	944-584
CP vs Betta 0 J 0 0 0 MACH, BETA CP vs Aleta C 0 0 0 PHI, MACH, X/LMP CP vs Betta 0 J 0 0 PHI, MACH, X/LMP CP vs Betta 0 J 0 0 PHI, MACH, X/LMP CP vs Betta 0 J 0 PHI, MACH, X/LMP CP vs Betta 0 J 0 PHI, MACH, X/LMP OF vs Betta 0 J 0 PHI, MACH, X/LMP OF vs X/LB D 0 D PHI, MACH, ALPHA OF vs X/LB D 0 0 PHI, MACH, BETA O M 0 -20 PO O M 0 -20 PO O M O -20 PO O M O -20 PO	Orbiter Base Pressures	CP vs ALPHA	ບ	0	0	0	0	MACH, ALPHA	054-744
CP vs ALPHA C 0 0 0 0 PHI, MACH, X/LMP CP vs BETA 0 J 0 0 0 PHI, MACH, X/LMP CP vs ALPHA C 0 0 0 PHI, MACH, X/LMP CP vs ALPHA C 0 0 0 PHI, MACH, X/LMM CP vs KETA 0 J 0 0 0 PHI, MACH, X/LMM Of CP vs X/LB D 0 0 0 0 PHI, MACH, ALPHA 0 N 0 -20 40 PHI, MACH, BETA 20 M 0 -20 40	Orbiter Base Pressures	CP VS BETA	0	ŗ,	0	0	0	MACH, BETA	451-454
CP vs BETA 0 J 0 0 0 PHI, MACH, X/LNP CP vs ALPHA C 0 0 0 0 PHI, MACH, X/LNM CP vs BETA 0 J 0 0 0 PHI, MACH, X/LNM Of CP vs X/LB D 0 0 0 PHI, MACH, X/LNM Of CP vs X/LB D 0 0 0 PHI, MACH, ALPHA 0 M 0 -20 40 PHI, MACH, BETA 10 M 0 -20 40	Upper MPS Nozzle Pressures		ບ	0	0	0	0	PHI, MACH, X/LMP	455-456
CP vs Aleha C 0 0 0 0 PHI, MACH, X/IMM CP vs field Jo 0 0 0 PHI, MACH, X/IMM Of CP vs X/ILB D 0 0 0 0 PHI, MACH, ALPHA Of M 0 -20 40 PHI, MACH, BETA JO M 0 -20 40 Y PHI, MACH, BETA	Upper MFS Nozzle Pressures	CP vs BETA	0	h	0	0	0	PHI, MACH, X/LNP	457-458
CP vs feta 0 J 0 0 0 PHI, MACH, X/LWM ution of CP vs X/LB D 0 0 0 bto PHI, MACH, ALPHA ssures 0 M 0 -20 bto PHI, MACH, BETA 10 M 0 -20 bto	OMS Nozzle Pressures	CP VS ALPHA	ບ	0	0	0	0	PHI, MACH, X/LNM	1459-460
al Distribution of CP vs X/LB D O O O b b PHI, MACH, ALPHA selage Pressures O M O -20 b PHI, MACH, BETA 10 M O -20 b PHI, MACH, BETA	OMS Nozzle Pressures	CP vs ÉETA	0	t,	0	0	0	PHI, MACH, X/LAM	161-462
CP vs x/LB D 0 0 0 40 PHI, MACH, ALLTHA 0 M 0 -20 40 PHI, MACH, BETA 10 M 0 -20 40	Test OAL2C						-		7.60
10 M 0 -20 40 PHI, MACH, BETA 20 M 0 -20 40	Longitudinal Distribution of	CP VS X/LB	А	0	0	0	<u>0</u>	PHI, MACH, ALPHA	463-400
M 0 -20 40	Orbiter Fuselage Pressures 		0	X	0	-20	70		864-18ti
M 0 -20 40			10	X	0	-5			915-664
	>		20	×	0	-20	04	>	517-534

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3. Britis	TYPE OF PLOT	8		PARAMETERS de ^o r	ETERS OR	∂ RF	CONDITIONS VARYING	PAGES
4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	CP vs X/T.B) မှ	×	0	0	읓	PHI, MACH, BETA	535-552
Longitudinal Distribution of Orbiter Fuselage Pressures		. 0	×	10	0	04		553-570
		0	×	-50	0	2		571-588
	->	0	Z	04-	0	04	J ena	909-685
	CP VS X/CW	A	0	0	0	약	Y/BW, MACH, ALPHA	607-618
Chardwise Distribution of Upper and Lower Surface Wing		0	×	0	-20	9	Y/BW, MACH, BETA	619-630
Pressures		20	X	0	-50	04		631-642
		20	35	0	-50	9		643-654
		9	×	0	0	04		999-559
		0	×	91	0	04		667-678
		10	×	10	0	04		069-619
		8	×	10	0	01	<u> </u>	691-702
		0	×	-20	0	04	 -	703-714
		25	×	25	0	9		715-726
		8	×	-20	0	04		727-738
	->-	0	Z	04-	0	04	>	739-750
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	TYPE OF			PARAM	PARAMETERS		CONDITIONS	
TITI	PLOT	8	8	e e	Å.	RF	VARYING	PAGES
Chordwise Distribution of	CP vs x/CW	ន	×	04-	0	04	Y/BW, MACH, BETA	751-762
Upper and Lower Surface Wing Pressures		20	×	04-	0	04	Y/BW, MACH, BETA	763-774
Chordwise Distribution of	CP VS X/CV	А	0	0	0	04	Z/BV, MACH, ALPHA	775-786
Left and Right Surface Vertical Tail Pressures		0	×	0	-20	04	Z/BV, MACH, BETA	187-798
		97	×	0	-20	04		799-810
		20	×	0	-20	04		811-822
	·	9	×	0	0	9		823-83#
-		8	×	0	-50	04	>	835-846
Orbiter Base Pressures	CP vs ALPHA	A	0	0	0	04	MACH, ALPHA	847-850
Orbiter Base Pressures	CP vs BETA	0	Z	0	-20	710	MACH, BETA	851-854
Upper MFS Nozzle Pressures	CP VS ALPHA	A	0	0	0	9	PHI, MACH, X/LNP	855-856
Upper MFS Nozzle Pressures	CP vs BETA	0	×	0	-20	04	PHI, MACH, X/LAR	857-858
ONS Nozzle Pressures	CP VS ALPHA	A	0	0	0	9	PHI, MACH, X/LAW	859-860
ONS Nozzle Pressures	CP VS BETA	0	×	0	-20	04	PHI, MACH, X/LNM	861-862

INDEX OF DATA FIGURES (CONCLUDED)

PARAMETER SCHEDULES:

ALPHA

- A) -4, 0, 4, 8 Degrees
- B) -8, -6, -4, -2, 0, 2, 4, 6, 8 Degrees
- c) -4, 0, 5, 10, 15, 20, 22.5 Degrees
- D) 0, 5, 10, 15, 20 Degrees

BETA

- E) -4, 0, 4, 8 or -4, 2, 4, 8 Degrees
- F) -8, -6, -4, -2, 0, 2, 4, 6, 8 Degrees
- G) -7, -5, 3, 5, 7, 9 Degrees
- H) -8, -6, -4, -2, 2, 4, 6, 8 Degrees
- I) -5, 5, 7, 9 or -6, 4, 6, 8 Degrees
- J) --10, -5, 5, 10 Degrees
- K) -8, -4, 0, 4, 8 Degrees
- L) -10, C, 10 Degrees
- M) -6, -3, 0, 3, 6 Degrees

INTRODUCTION

The 0.030-scale Aero Loads Space Shuttle model was tested in the Unitary Plan Wind Tunnels at ARC starting April 2, and continuing through May 17, 1973 as follows:

IA9A OA12A IA9C OA12C	11-foot Transonic 11-foot Transonic 8x7-foot Supersonic 8x7-foot Supersonic	April 2 to April 14, 1973 April 16 to April 29, 1973 April 23 to May 1, 1973 May 2 to May 8, 1973 May 9 to May 17, 1973
IA9B	9x7-foot Supersonic	May 9 to May 11, 1913

The testing was conducted in all three legs of the Unitary Plan Wind Tunnels to obtain a Mach number range from 0.6 to 3.5. Aerodynamic loads data were obtained for the ascent and entry configurations. The effects of control surface deflections were also investigated.

This report consists of 3 volumes of force data and 15 volumes of pressure data for a total of 18 volumes arranged in the following manner:

VOLUME NO.	CONTENTS
1 2 3 4 5 6	IA9A force data IA9B and IA9C force data OA12A and OA12C force data IA9A plotted pressure data IA9B and IA9C plotted pressure data
6 7	OA12A and OA12C plotted pressure data IA9A tabulated pressure data (a) orbiter fuselage (b) orbiter base (c) upper MPS nozzle
8	TA9A tabulated pressure data (a) CMS nozzle (b) body flap (c) CMS pod outside (d) lower wing surface
9	IA9A tabulated pressure data (a) upper wing surface (b) left vertical tail surface (c) right vertical tail surface (d) APU inlet (e) SRM booster base
10	IA9A tabulated pressure data (a) SRM booster (b) external tank (c) external tank base

INTRODUCTION (CONTINUED)

11	IA9B tabulated pressure data
	(a) orbiter fuselage
	(b) orbiter base (c) upper MPS nozzle (d) OMS nozzle (e) body flap
	(c) upper MPS nozzle
	(d) QMS nozzle
	(e) body flap
	(r) ums bed outside
	(g) lower wing surface
12	IA9B tabulated pressure data
	(a) upper wing surface
	(b) left vertical tail surface
	(c) right vertical tail surface
•	(d) APU inlet
	(e) SRM booster base (f) SRM booster
	(f) SRM booster
	(g) external tank
	(h) external tank base
13	IA9C tabulated pressure data
-3	(a) orbiter fuselage
	(b) orbiter base
	(c) upper MPS nozzle
	(d) OMS nozzle
	(c) upper MPS nozzle (d) QMS nozzle (e) body flap
	(f) QMS pod outside
14	TAGC tabulated pressure data
	(a) lower wing surface (b) upper wing surface
	(b) upper wing surface
	(c) left vertical tail surface
	(d) right vertical tail surface
15	IA9C tabulated pressure data
-,	(a) APU inlet
	(b) SRM booster base
	(c) SRM booster
	(d) external tank
	(e) external tank base
16	AAIOA tahulatad managura data
	(a) orbiter fuselage
	(a) orbiter fuselage (b) orbiter base (c) upper MPS nozzle (d) CMS nozzle
	(c) upper MPS nozzle
	(d) QMS nozzle
	(e) podlitah
	(f) CMS pod outside

INTRODUCTION (CONCUMENT)

OAL A tabulated pressure tata

(a) lower wing surface
(b) upper wing surface
(c) left vertical tail carface
(d) right vertical tail carface
(e) APU inlet

OAL C tabulated pressure data
All components

NOMENCLATURE General

YMBOL.	CADDAC CYMBOL	DEFINITION
•		speed of sound; m/sec, ft/sec
Ç.	C.F.	pressure coefficient; $(p_1 - p_{\infty})/q$
M	MA CH	Moch number; V/a
F		pressure; N/m², psr
i	·(NSM) ·(PSF)	iynemic pressure; 1/2pV2, N/m2, psf
RN/L	AN/L	unit Reynolds number; per m, per ft
v		velocity; m/sec, ft/sec
a	Alpha	angle of attack, degrees
β	PETA	ungle of sideslip, degrees
ψ	PJI	angle of yaw, degrees
φ	PHI	angle of roll, degrees
P		mass density; k_6/m^3 , slugs/ft ³
		Reference & C.G. Definitions .
Áţ		base areo; m ² , ft ²
t	BREF	wing span or reference span; m, ft
0 • 6 •		center of gravity
l em∙ ë	LREF	reference length or wing mean aerodynamic chord; m, ft
	SREET	wing area or reference area; m ² , ft ²
	MRP	moment reference point
	XMRF	moment reference point on X axis
	WRP	moment reference point on Y axis
	IMRP	moment reference point on Z sxis
. VB.)(T	RIPTO	
ţ,		bose local
<u> </u>		static conditions
t. 300		total conditions free stream

NOMENCLATURE (Continued)

Body-Axis System

SYMBOL	SADSAC SYMBOL	DEFINITION
$c_{ m N}$	CN	normal-force coefficient; normal force qS
c_{A}	CA	axial-force coefficient; axial force
c¥	CY	side-force coefficient; side force qS
$c_{A_{\hat{\mathbf{b}}}}$	CAB	base-force coefficient; $\frac{\text{base force}}{\text{qS}}$ $-A_b(p_b - p_{\infty})/\text{qS}$
$^{\mathrm{C}}_{\mathbf{A_{f}}}$	CAF	rcrebody axial force coefficient, CA - CAb
c_m	CIM	pitching-moment coefficient; pitching moment qS \mathbf{l}_REF
c_n	CYN	yawing-moment coefficient; yawing moment qSb
c l	CBL	rolling-moment coefficient; rolling moment
		Stability-Axis System .
$\mathtt{c}_{\mathtt{L}}$	CL	lift coefficient; lift qS
c_{D}	CD	drag coefficient; drag qS
$c_{D_{\pmb{b}}}$	CDB	base-drag coefficient; base drag
$\mathbf{c}_{\mathbf{D_f}}$	CDF	forebody drag coefficient; CD - CDb
$\mathbf{c}_{\mathbf{Y}}$	CY	side-force coefficient; side force qS
C _m	CLM	pitching-moment coefficient; pitching moment
$^{\mathtt{c}}_{\mathtt{n}}$	CLN	yawing-moment coefficient; yawing moment qSb
с б	CSL	rolling-moment coefficient; rolling moment
r/ D	r/p	lift-to-drag ratio; C _L /C _D
r/d	I/DF	lift to forebody drag ratio: $c_{ m L}/c_{ m Df}$

これのの一般はいからい、これのなかのある 養養な事を教をまるときるのでは、

NOMENCLATURE (CONTINUED)

ADDITIONS TO STANDARD LIST

SYMBOL	PLOT SYMBOL	DEFINITION
ø _R	RUDDER	rudder, surface deflection angle, positive deflection, trailing edge to the left; degrees.
ő e	ELEVON	elevon, surface deflection angle, positive deflection, trailing edge down; degrees.
ô _{RF}	RUDFLR	rudder flare, split rudder deflection angle, left split rudder trailing edge left and right split rudder trailing edge right, $\delta_{\rm RF} = (\delta_{\rm RL} + \delta_{\rm RR})/2$, positive deflection; degrees.
io	ORBINC	incidence angle between the orbiter and external tank, $i_0 = \alpha_t - \alpha_t$; degrees.
$oldsymbol{eta}_{ m T}$	BETAT	angle of sideslip of external tank.
$oldsymbol{lpha_{ ext{T}}}$	ALPHAT	angle of attack of external tank.
$\ell_{ m B}$	LB	length of orbiter body; in.
$m{\ell}_{ ext{T}}$	LT	length of external tank; in.
l s	LS	length of SRM booster; in.
<i>l</i> nm	Lim	length of OMS nozzle, positive direction forward of exit plane; in.
$\ell_{ ext{NP}}$	LNP	length of MPS nozzle, positive direction forward of exit plane; in.
b/2	BW	wing seri-span; in.
b _v	BV	vertical tail span; in.
x	x	distance from component nose; in.
У	Y	lateral distance from centerline; in.

NOMENCLATURE (CONCLUDED)

SYMBOL	PLOT SYMBOL	DEFINITION
Z	Z	vertical distance measured from W.L. 500 (vertical tail reference root chord); in.
c _w	CW	local wing chord; in.
c _v	cv	local vertical tail chord; in.
x/L B	X/LB	longitudinal position/orbiter body length.
x/L m	x/lt	longitudinal position/external tank length.
x/ L S	x/ls	longitudinal position/booster length.
x/L nm	x/lm	longitudinal position/OMS nozzle length.
x/L NP	X/LNP	longitudinal position/MPS nozzle length.
x/c _w	x/cw	local chordwise position/local wing chord length.
x/c _v	x/cv	local chordwise position/local vertical tail chord length.
y/b/2	Y/BW	local spanwise position/wing semi-span.
2/b _v	z/bv	local spanwise position/vertical tail span.

CONFIGURATIONS INVESTIGATED

The 0.030-scale aero loads model was a replica of the Space Shuttle Vehicle 2A. It consisted of four major components: the orbiter, the external oxygen and hydrogen tank (ET) and two solid rocket boosters (SRB).

On the ascent configuration, the orbiter was strut mounted from the ET on a Task Corporation MK XVI 2.5-inch diameter internal balance. The left SRB was strut mounted from the ET on a Task Corporation MK XXII 1.5-inch diameter internal balance. No attempt was made to simulate actual inter-attachments. The ET was sting mounted to the tunnel model support system on a Task Corporation 4.0-inch diameter internal balance. The right SRB was strut mounted symetrically to the left side, but did not contain a balance. The orbiter configuration, designated as O2A, consisted of B10C5D7W87V5R5M3F4.

The entry configuration consisted of the isolated orbiter, sting mounted to the tunnel model support system on a Task Corporation MK XXA 2.5-inch diameter internal balance. Midway through the OAl2C test, the MK XXA balance was damaged and was replaced by the MK XXB for the high angles of attack. The orbiter was provided with deflectable elevons by means of interchangeable brackets, deflectable rudder by means of a pinindexed hinge, and interchangeable rudders to obtain different speed brake flare angles. The main propulsion system engines were removed during entry configuration testing to provide sting clearance. A cover plate was provided for the strut clearance hole.

The orbiter was instrumented with 374 pressure orifices on the left wing, left side of the fuselage, vertical tail, left CMS pod and engine, left and upper MPS engine and the base. The pressures were measured using eleven Scanivalve, Inc., S-type valve modules mounted internally (a five and a six gang unit). When tested in the entry configuration, the MPS pressures were not available for measurement.

The left side of the ET was instrumented with 136 pressure orifices. These pressures were measured by means of 7 Scanivalve, Inc., S-type valve modules configured as one unit of 6 modules and one single. These valves were mounted internally in the tank. The left SRB had one gang of six S-type modules to measure 102 pressures. The right SRB was not instrumented. The pressure transducers used in the valve modules were Statham PM 131 TC differential pressure transducers, with ranges of ±10 psid, ±12.5 psid and ±15 psid. Reference and calibration pressures were measured by the ARC micro manometers.

Some modifications were made to the model at the test site prior to

CONFIGURATIONS INVESTIGATED (CONTINUED)

testing. These were as follows:

- 1. The forward tip of the ET containing the retro rocket package (Reference NR Drawing VL78-000018) was replaced with a flush 0.90 inch radius nose (Model scale). The new nose had five pressure taps; one in the nose and four more aft of the nose on the vertical and horizontal axis on a 0.315 inch radius.
- 2. The ET balance cavity was enlarged by one inch on the diameter (from 5 inches to 6 inches) to provide clearance for cable routing and eliminate balance interference.
- 3. The clearances around both the orbiter and the SRB struts were opened to approximately 1/8 inch to prevent interference.
- 4. An alternate rudder hinge pin was provided to give a rudder deflection of +15 degrees.

Before and during the tests various model discrepancies developed or were discovered. These were generally minor and had only a negligible, if any, effect on the data. Significant discrepancies are noted below:

- 1. Pressure orifices P171 and P173 on the OMS pod base were omitted.
- 2. During the test certain pressure taps developed leaks or became plugged. Data from these taps are questionable and should be used with caution. Difficulties in checking may have resulted in erroneous indications of leakage. Repairs were made to correct leaking or plugged pressure instrumentation, whenever possible, as the test progressed. The following list gives those taps that were indicated as bad on the various leak and response checks:

ARC Facility	Run Nos.	Orifice numbers with questionable pressure data	
11'	2-4	72, 163, 427	
	5-118	31, 100, 123, 163, 201, 427	
	119-160	16, 98, 101, 107, 333, 427	
\psi	161-170	16, 98, 101, 107, 333, 427 + 306, 307, 327, 328, 336, 337, 356, 357, 375	

CONFIGURATIONS INVESTIGATED (CONCLUDED)

ARC Facility	Run Nos.	Orifice numbers with questionable pressure data
11'	171-182	16, 47, 53, 75, 78, 98, 107, 201, 236, 237, 238, 307, 327, 365, 427
	183-189	Same as (171-182) + 7, 447, 525
Y	190-211	Same as (171-182)
8'x7'	220-234	20, 21, 24, 74, 326, 327, 336, 424, 427, 752, 868, 871
	235-285	74, 326, 327, 336, 424, 427, 752, 868, 871
	286-300	74, 107, 115, 124, 129, 138, 326, 327, 336, 427
	301-305	74, 326, 327, 336, 427
Y	306-333	74, 326, 327, 427
9 ' x7'	340-396	5, 325, 326, 327, 424, 427, 526, 752, 868, 871

TEST FACILITIES DESCRIPTION

Ames 11 x 11-Ft. Transonic

The Ames 11 x 11-Foot Transonic Wind Tunnel is a variable density, closed return, continuous flow type. This tunnel has an adjustable nozzle (two flexible walls) and a slotted test section to permit transonic testing over a Mach number range continuously variable from 0.4 to 1.4.

Ames 8 x 7-Ft. Supersonic

The Ames 8 x 7-Foot Supersonic Wind Tunnel is a closed-return, variable-density tunnel with a 8- by 7-foot rectangular test section. The nozzle has flexible side walls with fixed upper and lower surfaces. Mach number range is continuously variable from 2.45 to 3.5. Tunnel stagnation pressure can be varied from 0.3 to 2.0 atmospheres and Reynolds number per foot varies from 1.0 x 10^6 to 5.0 x 10^6 .

Ames 9 x 7-Ft. Supersonic

The Ames 9 x 7-Foot Supersonic Wind Tunnel is a variable density, continuous flow type with an adjustable nozzle to permit supersonic testing over a Mach number range continuously variable from 1.5 to 2.5. The nozzle is of the asymmetric, sliding-block type in which the variation of the test section Mach number is achieved by translating, in the streamwise direction, the fixed-contour block that forms the floor of the nozzle.

DATA REDUCTION

Standard procedures were utilized to reduce force and pressure data to coefficient form. The following dimensional constants were applied:

Reference Dimensions and Constants (Model Scale)

7.10402 2041201	
$S_{Ref.} = 2.421 \text{ ft}^2$	Orbiter reference area
$Q_{Ref.} = 39.849 in.$	Orbiter reference length
Base Areas (Model Scale)	
$A_{BOI} = 0.1903 \text{ Ft}^2$	Orbiter base area, integrated
$A_{BOA} = 0.2362$	Orbiter base area, sting mounted
$A_{\text{BMPSU}} = 0.0417$	Orbiter upper MPS base area
$A_{\text{BMPSL}} = 0.0853$	Orbiter lower MPS base area
ABACPS = 0.0310	Orbiter ACPS base area on OMS pod
$A_{BOMS} = 0.0231$	Orbiter OMS nozzle base area
$A_{BPOD} = 0.0257$	Orbiter OMS pod base area
Aco = 0.0611	Orbiter sting cavity base area
$A_{BNOZ} = 0.0564$	SRM nozzle base area
$A_{BSKIRT} = 0.1729$	SRM nozzle skirt base area
ABETT = 0.3189	ET Base area
A _{CET} = 0.1964	ET Sting cavity base area

: OA12 /1	TABLE	I.	DATE: May, 1973
	TEST CONI	DITIONS	
MACH NUMBER	REYNOLDS NUMBER (per unit length)	DYNAMIC PRESSURE (pounds/sq. foot)	STAGNATION TEMPERATURE (degrees Fahrenheit)
0,6	4.0 X 106	540	120° NOM.
0,9	4.5	800	
11	4.0	800	
1.25	3.0	630	
1.4	3.0	650	
1.55	2,8	600	
2.0	2.3	490	
2.5	1.5	300	
3.0	2.0	3.50	Y
3,5	2.0	300	·
	ļ		

FIVE (5) TASK CORPORATION BALANCES

BALANCE UTILIZED: WITH CAPACITIES AS FOLLOWS:

ISOLATED ORBITER			
	MKTTA	MK 🖾 B	
NF	3000	3000	
NA	3000	3000	
YF	1500	1500	
YA	1500	1500	
×	600	600	
R	4000	4000	
12F	2.5"	2.5	

SIZE

LNTEGRA ORO MK XXX	SRB MK.BX	MKITB
2400	1250	4000
2400	1250	4000
1200	580	2000
1200	500	2000
1500	200	1000
4000	1000	10,000
2.5'	1.5"	4.0"

COMMENTS: THE MARK ITA, 250 DIA. BALANCE WAS DAMAGED AFTER RUN 319. THE MARK III WAS SUBSTITUTED FOR RUN 320 AND SUBSEQUENT RUNS

TABLE II.

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TABLE II. CONTINUED

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TABLE II. CONTINUED

						DATE: 5-1-73	٦
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			MACH NUM	BERS (OR ALTERNA	MACH NUMBERS (OR ALTERNATE INDEPENDENT VARIABLE)	T
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	00	7	247	237	227		IN N
	20		248	238	228		UMB
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		J\	392	1257	157		
	21	<i>b</i> -	265	258	252		
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TABLE II. CONTINUED

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TEST:		CATA SET	024/2/7									38												_	1		SC

TABLE II. CONTINUED

LTERNATE INDEPENDENT VARIABLE)	FRSYALUES NO. MACH NUMBERS (OR ALTERNATE INDEPENDENT VARIABLE) 0 FR 0.6 0.9 1.0 <th>SS 61 67</th> <th>LTERNATE INDEPENDENT VARIABLE) 1. TERNATE INDEPENDENT VARIABLE (1) 1. TERNATE INDEPENDENT VARIABLE (2) 1. TERNATE INDEPENDENT (3) 1. TERNATE INDEPENDENT (4) 1. TERNATE INDEPENDENT (5) 1. TERNATE INDEPENDENT (1) 1. TERN</th> <th>DATA SET/RUN NUMBER COLLATION SUMMARY</th>	SS 61 67	LTERNATE INDEPENDENT VARIABLE) 1. TERNATE INDEPENDENT VARIABLE (1) 1. TERNATE INDEPENDENT VARIABLE (2) 1. TERNATE INDEPENDENT (3) 1. TERNATE INDEPENDENT (4) 1. TERNATE INDEPENDENT (5) 1. TERNATE INDEPENDENT (1) 1. TERN	DATA SET/RUN NUMBER COLLATION SUMMARY
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TABLE II. CONTINUED

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11-707		CONFIGURATION	A C O M.E.M.M.V.D.W.E.	NSUTURNE AND																	13	-	A A A
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TABLE III. MODEL COMPONENT DIMENSIONAL DATA

•	Body Fuselage, 2A Configura	tion, Lightweig	ht Orbiter, per
GENERAL DESCRIPTION:	,		·
Rockwell Lines VL70-00	00089 "8."	· · · · · · · · · · · · · · · · · · ·	
Scale Model = .030			
DRAWING NUMBER:	VL70-000089 "B" VL70-000092, 93,	94 "A"	
DIMENSIONS:		FULL-SCALE	MODEL SCAL
Length_IN	•	1328.3	39.8490
Max. Width ~ IN	(ex _o = 1528.3)	265.0	7.9500
Max. Depth ∼IN.	$(@X_0 = 1480.52)$	248.0	7.4400
Fineress Ratio		5.012	5.012
Area_Ft2	•		•
Max. Cross-	Sectional	456.4	.41076
Planform	•	·	
Wetted	•		, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Raco	41.4	3,000 a	

MODEL COMPONENT: Canopy - C	5	•	<u> </u>
GENERAL DESCRIPTION: 2A Config	uration per 1	Lines VL70-00009	2
		•	
Scale Model = .030		•	•
DRAWING NUMBER: VI.7	0-000 092		
DIMENSIONS:		FULL-SCALE	MODEL SCALE
Length (STA FWD Bulkhead	i)	391.0	11.730
Max. Width (T.E. Bulkhead))	560.0	16,800
Max. Depth (WP = 42.9	22 to = 500	0)	
Fineness Ratio			
Area	•		
Max. Cross-Sectional		•	
Planform	•		
Wetted			
Base			· · · · · ·

ENERAL DESCRIPTION: _24	A Configuration per	Rockwell Lines V	170-00093
			• •
•			
Scale Model = .030		· •	•
DRAWING NUMBER:	V1.70-000093	-	
IMENSIONS:		FULL-SCALE	MODEL SCAL
Length ~ IN.	•	881.00	26.430
Max. Width~IN.		51.00	1.530
Max. Depth ∼IN.		23.00	.690
Fineness Ratio	· •.		
Area			
Max. Cross-Sa	ctional		
Planform	••		•
Wetted			
. Base		• • •	
E Fuselage BP =	0.00	Strain Court of the Court of th	
•	500.0 IN. FS	•	

MODEL COMPONENT: WING-W87 New Light Weight Orbite		
GENERAL DESCRIPTION: Orbiter Configuration Per Line	s VL70-000093.	
GENERAL DESCRIPTION OF DIEGI GOING	fore of the Wing	at the 75.33%
NOTE: (Dihedral Angle is defined at the lower sur	(ace or one many	
element line projected into a plane perpendiculary	·	
Scale Model = .030	DWG. NO. VL7	70-000093
TEST NO.		
DIMENSIONS:	FULL-SCALE	MODEL SCALE
marrie DATA		
TOTAL DATA Area (Theo.) Ft ²	o/oo oo	2.42100
Plantorm	2690.00 936.68	28.10040
Span (Theo In.	2.265	2.265
Aspect Ratio	1.177	1.177
Rate of Taper Taper Ratio	0.200	0.2000
Dihedral Angle, degrees	3.5000	3.500 +3.00
Incidence Angle, degrees	3.000	+3.000
Aemdonamic Twist. degrees	3.500	
Sweep Back Angles, degrees	45.00	45.00
Leading Edge	-10.24	-10.24
Trailing Edge 0.25 Element Line	35.209	35.209
Chords:	440.01	20.67720
Root (Theo) B.P.O.O.	689.24 137.85	4.13550
Tip, (Theo) B.P. 46834	<u> 137.83</u> <u> 174.81</u>	14.24430
MAC	1136.89	34.10670
Fus. Sta. of .25 MAC	299.20	8.97840
W.P. of .25 MAC	182.13	5.46390
183.13 B.L. of .25 MAC		2 E0004
EXPOSED DATA Area (Theo) Ft2	1752.29	1.57706
Span, (Theo) In. BP108 to 468.341	720.68	2.058
Aspect Ratio	2.058	2451
Taper Ratio	.2451	
Chords	562.40	16.8720
Root BP108	137.85	4.13550
Tip 1.00 <u>b</u>	393.03	11.79090
· MAC	1185.31	35.55930
Fus. Sta. of .25 MAC	300,207	9.00621
W.P. of .25 MAC	143.76	4.31280
B.L. of .25 MAC Airfoil Section (Rockwell Mod NASA)		
XXXX-64	20	.10
Root b = .425		
2	.12	.12
Tip <u>b</u> = 1.00		
Data for (1) of (2) Sides		
Leading Edge Cuff 2	120.33	10830
Leading Edge Cuff 2 Planform Area Ft2 Planform Area Ft2	560.0	16.80
indian Fine Intersects rus M. C. C. C.	1035.0	31.050
Leading Edge Intersects Wing @ Sta		-
1.7		

NERAL DESCRIPTION: 2A Configuration P	er W-87 Rockwell Line	s VI. 70-000093
Data for (1) of (2) Sides		•
Scale Model = .030		
RAWING NUMBER: VI. 70-000093		
IMENSIONS:	FULL-SCALE	MODEL SCALE
Area ~ Ft ²	205.52	<u>.18497</u> 10.600 <u>20</u>
Span (equivalent)~IN.	353.34	3.44340
Inb'd equivalent chord	114.78	
Outb'd equivalent chord		1.6500
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord		
At Outb'd equiv. chord		. 1.00
Sweep Back Angles, degrees		
Leading Edge	0.00	0.00
Tailing Edge		10.24
Hingeline	0.00	0.00
Area Moment (Normal to hinge lir Product of Area Moment	ne) Ft ³ 1548.07	.04180

MODEL COMPONENT: VERTICAL - V5 (Light W	eight Orbiter Configurati	ion)
GENERAL DESCRIPTION: Centerline Vertical	Tail, Double Wedge Airfo	oil with Rounded
Leading Edge		
Scale Model = .030		
DRAWING NUMBER: VI70-000	095	
DIMENSIONS:	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area (Theo) Ft ²	413.25	.37192
Planform Span (Theo) In	315.72	9.47160
Aspect Ratio Rate of Taper	1.675 0.507	1.675 0.507
Taper Ratio	.404	.404
Sweep Back Angles, degrees Leading Edge	45.000	45:000
Trailing Edge 0.25 Element Line	<u>26.249</u> 41.130	<u>26.249</u> 41.130
Chords:		
Root (Theo) WP Tip (Theo) WP	<u>268.50</u> 108.47	8.05500 3.25410
MAC	199.81	5.99430
Fus. Sta. of .25 MAC	1463.50 635.522	43.90500 19.06566
W. P. of .25 MAC B. L. of .25 MAC	0.00	0.00
Airfoil Section	 :	
Leading Wedge Angle Deg	10.000 14.920	10.000
Trailing Wedge Angle Deg Leading Edge Radius IN.	2.00	.06
Void Area Ft ²	13.17	.01185
Blanketed Area Ft ²	12.67	.01140

MODEL COMPONENT: R-5 Rudder		
GENERAL DESCRIPTION: ZA Configuration per	Rockwell Lines VL	70-000095
Scale Model = .030		
DRAWING NUMBER: VL 70-000095		
DIMENSIONS:	FULL-SCALE	MODEL SCALE
Area ~ Ft ²	106.38	09574
Span (equivalent) ~IN.	201.0	_6.030
Inb'd equivalent chord	91.585	2.71.755
Outb'd equivalent chord	50.833	1.52499
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	0.400	0.400
At Outb'd equiv. chord	0.400	0.400
Sweep Back Angles, degrees	•	· •
Leading Edge	34.83	34.83
Tailing Edge	26.25	2 ⁴ , 25
Hingeline	34.83	34.83
Area Moment (Normal to hinge line) ~ Product of Area and Mean Chord	-Ft ³ 526.13	_01421

NERAL DESCRIPTION: <u>2A Li</u>	ght Weight Config	uration per Rock	well Lines
Scale Model = .030		··	·
RAWING NUMBER:	V170-000094A		
IMENSIONS:		FULL-SCALE	MODEL SCA
Length	•	346.0	10.380
Max. Width $X = 145$	0.0	108.0	3.240
Max. Depth $X_0 = 150$	0.0	113.0	3.390
Fineness Ratio	·		
Area	•	•	
Max. Cross-Secti	onal		
Planform		•	
Wetted			-
. Base	•	•	٠

D of OMS Pod

WP = 463.9 IN. FS WP 400 + 63.9 = 463.9

BP = 80.0 IN. FS

Length 1214.0 to 1560.0' = 346.0 IN. FS

ENERAL DESCRIPTION: 2A	Configuration per R	ockwell Lines VL	70-00094A
•			
Scale Model = .030		•	•
DRAWING NUMBER:	V170-000094A	:	
DIMENSIONS:		FULL-SCALE	MODEL SCAL
Length		84.70	2.541
Max. Width		265.00	7.950
Max. Depth	•		•
Fineness Ratio			•
Area ~ Ft ²	•	•	•
Max. Cross-Se	ctional		***************************************
Planform		142.64	.12838
Wetted	•		

TABLE III. (CONTINUED) MODEL DIMENSIONAL DATA

MODEL COMPONENT : S3-Booster Solid Rocket Motor
GENERAL DESCRIPTION: 2A Configuration Per Rockwell Lines VL77-000012 & VL72-000061 "B"
Body of Revolution; Data for (1) of (2) Sides
Scale Model = .030
DRAWING NUMBER: VL 77-000012

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length ~IN.	1732.0	51.96
Max Width (DIA) IN. BSRM Tank	142.0	4.260
Max Depth (DIA) Aft Skirt	259.0	7.77
Fineness Ratio L/D	6.687	6.687
Area ~ Ft ²		
Max. Cross-Sectional (Aft	365.87	.32928
Skirt) Planform		
Wetted		
Base		

Ref.

FS (Orbiter) = 0.00 = 747.99 IN. ET = 200.0 IN. BSRM

WP (BSRM) = WP 400(Orbiter) - 344.413 = 55.587 IN.

BP (Orbiter) = 0.00 = 243.0 IN. BSRM

TABLE III. (CONCLUDED)

MODEL COMPONENT: EXTERNAL TANK - T9	<u> </u>	
	•	
GENERAL DESCRIPTION: 2A Configuration		
GENERAL DESCRIPTION: 2 Ook 18 at 2010.		
	<u> </u>	
NOTE: T9 identical to T8 W/O retro pkg	., nose w/30"R F.S.	
DRAWING NUMBER NONE		
DIMENSION:	FULL SCALE	MODEL SCALE
Length - IN.	1858	55.740
Max Width (Dia) - IN.	324.0	9.720
Max Depth		
Fineness Ratio L/D	5.73457	5.73457
Areo - FT ²	• .	•
Max Cross-Sectional	572.56	0.51530
Planform		
Wetted	•	
Base		•
Nose, Radius, IN.	30.0	

180	23 32 41 50 72 93 107 115 129 138
172	09
169	τ.
165	. 82 90 98 106 11. 11. 154 1162 1170
162	70
157	61
150	31 49 49 58 69 97 105 1128 1128 1153 1153 1153
142	. 73
135	135 144 152 168
120	30 39 468 57 68 88 88 96 104 112 1134 1143 1151 1151 1151 1173
011	171 172
105	133 142 150 158
8	22 33 44 56 103 111 1120 126 126 149 149 165
20	28 146 110 110 110 110 110 110 110 11
55	27 36 45 54 54 65
01	26 35 44 53 64 64 100 110 110 110 110 110 110 110 110 11
20	25 43 52 75 75 75
0	20 21 24 51 74 84 92 100 108 1163
х,/д	. 008 . 008 . 009 . 034 . 050 . 136 . 151 . 158 . 173 . 226 . 320 . 335 . 512 . 512 . 512 . 512 . 513 . 512 . 513 . 173 . 174 .
MODEL	6.00 6.30 6.30 11.40 12.90 12.90 15.00 16.80 16.
FULL	200 210 225 245 245 280 380 400 400 400 625 725 880 625 725 880 1180 1180 1180 1180 1180
	MODEL X_/1 0 20 40 55 70 90 105 110 120 135 142 150 157 162 165 169 172

. OFS POD, INSIDE

b oms pod, outside

a. Orbiter body

Table IV. Pressure Orifice Locations

ORBITER BASE

LOCATION	ORIFICE NUMBERS
ORBITER BASE (INTEGRATED) LEFT MPS NOZZLE BASE	1, 2, 3, 4
TIPER MPS NOZZIE BASE ACTS BASE AREA ON OMS POD	7 0
OMS NOZZLE BASE OMS POD BASE	000
OBBITER BASE (STING MOUNT)	11, 12, 13, 14 15, 16

SURFACE	θ ~ DEG	017 0
BODY FLAP LWR SURFACE	ORB. STA. ~ X	FULL MODEL

176

175

17.40

1580

AVIII	MPS NOZZIÆ	$ heta \sim ext{DEG}$.
PETTER STIME CAVITY		X ~ IN. FWD BASE

_			
		225	179
	θ ~ DEG	180	178 180
OMS NOZZLE	. 60	135	177
CIMIS 1	X ~ IN FWD BASE	MODEL	0.30
	X ~ X	FULL	10 20

-3

VERTICAL TAIL

186 192 197

1.85 1.91 1.96

184 190 195

183 189 194

182 188 193

181 187

0.75 1.50 225

25 50 75

135 180

8

MODEL

FULL

WAT	WATER PLANE $\sim Z_0$. Z		×	/c ~ 2/	X/c ~ THEORETICAL VERTICAL CHORD	TTCAL	VER'	TCAL	CHORD	
FULL	MODEL	24		0	.05	.15	.30	.52	.65	.775	9
525	15.75	.079		00 1							
550	16.50	.158	11 82	110	111	412 512	413 513	414 514	415 515	416 516	
9	19.00	.316	i ii	120	121	1,22 5,22	423 523	424 524	425 525	426 526	427 527
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Orbiter Base, Body Flap Lower Surface, and Vertical Tail Table IV. Continued. ۾

ORBITIER WING

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U - UPPER SURFACE L - LOWER SURFACE

I		•
	X/C LOCAL WING CHORD	
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36	_	
12	0, .081, .177, .402, .565, .760, .808,.857, .905, .953	.953
153	SAME AS THEORETICAL CHORD	
.6T3		
.780		
.897		

c. Orbiter Wing Table IV. Continued.

EXTERNAL TANK

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THE A CO.	TWI	יייות	316.	317.7		520	270	670	7.5	750	850	950	1050	1150	1250	1350	1500	1700	1900	2040	STING	BASE

d. External Tank Table IV. Continued.

LEFT SRM

SRM	STATION ~	- XS					θ~	DEG		
FULL	MODEL	xs/ls	0	45	90	135	180	225	270	315
200 260 370 400 450 550 700 850 1050 1250 1450 1750 1790 1850 1900	6.00 7.80 11.10 12.00 13.50 16.50 21.00 25.50 31.50 43.50 49.50 52.50 53.70 55.50 57.00 NOZZLE BA		810 811 821 831 841 851 861 871 881 901 911 921 931 941 951 802	812 822 832 842 852 922 932 942 952	813 823 833 843 853 863 873 883 903 913 923 923 943 953	314 824 834 854 924 934 954	815 825 835 845 855 865 875 885 905 915 925 935 945 955	816 826 836 846 856 866 926 936 946 956	817 827 837 847 857 867 877 907 917 927 937 947 957	818 828 838 848 858 868 928 938 948 958

e. Left SRM

Table IV. Concluded.

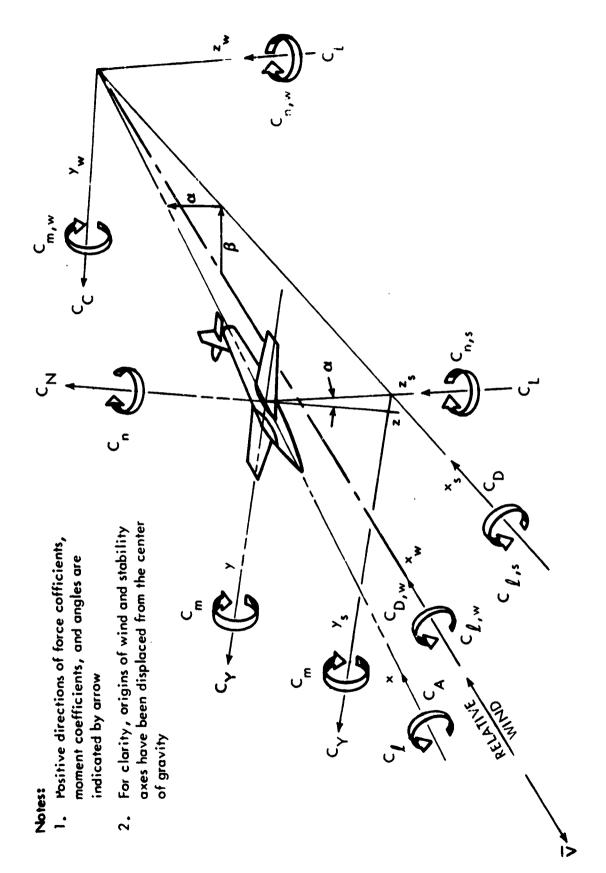
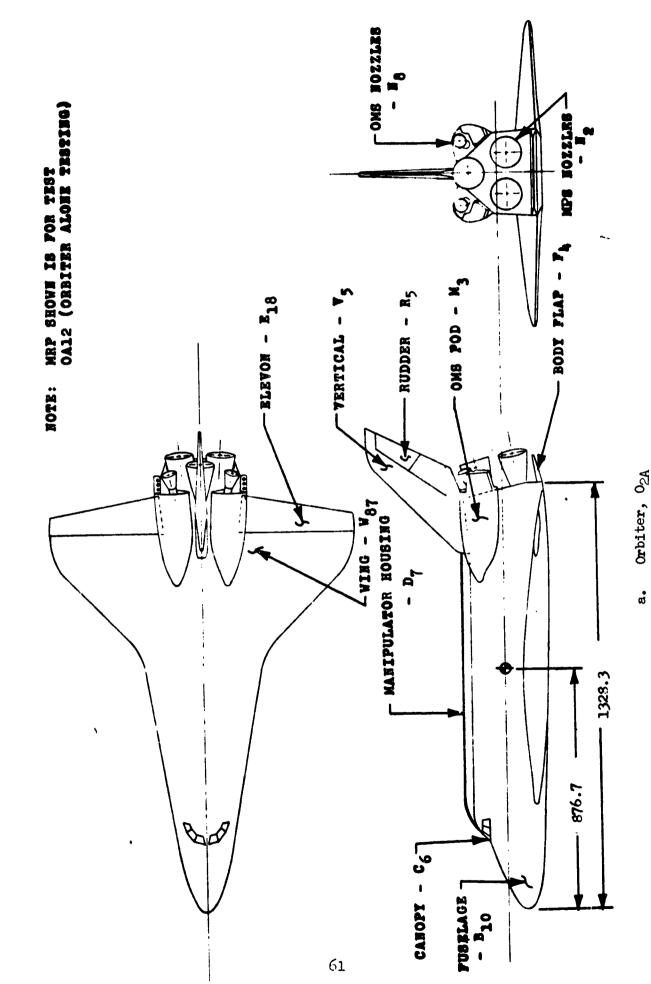
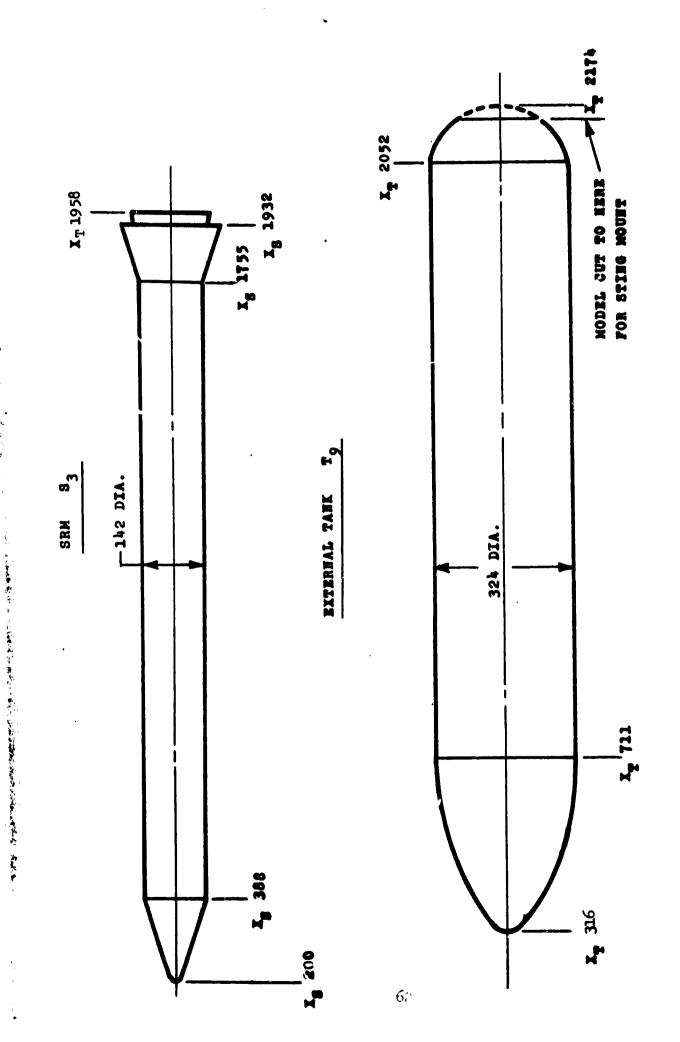


Figure 1. - Axis Systems.

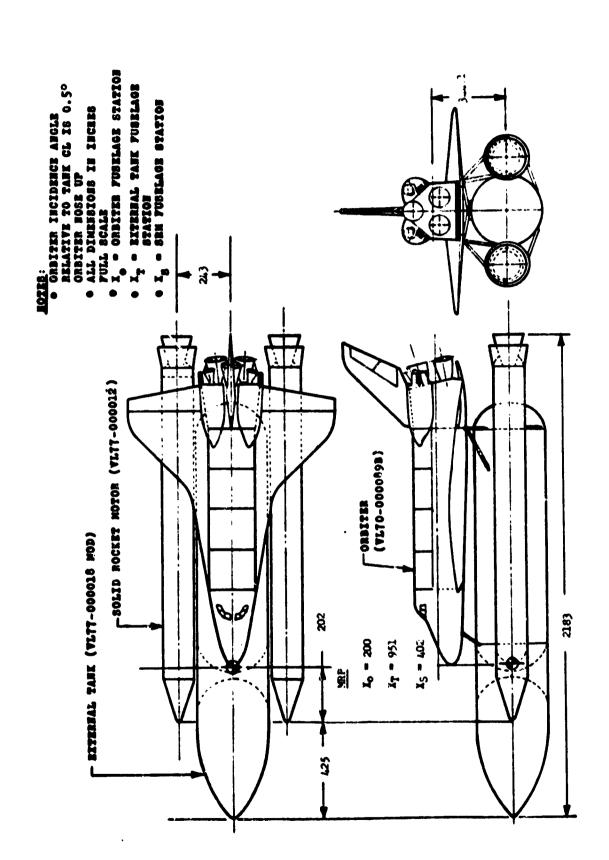
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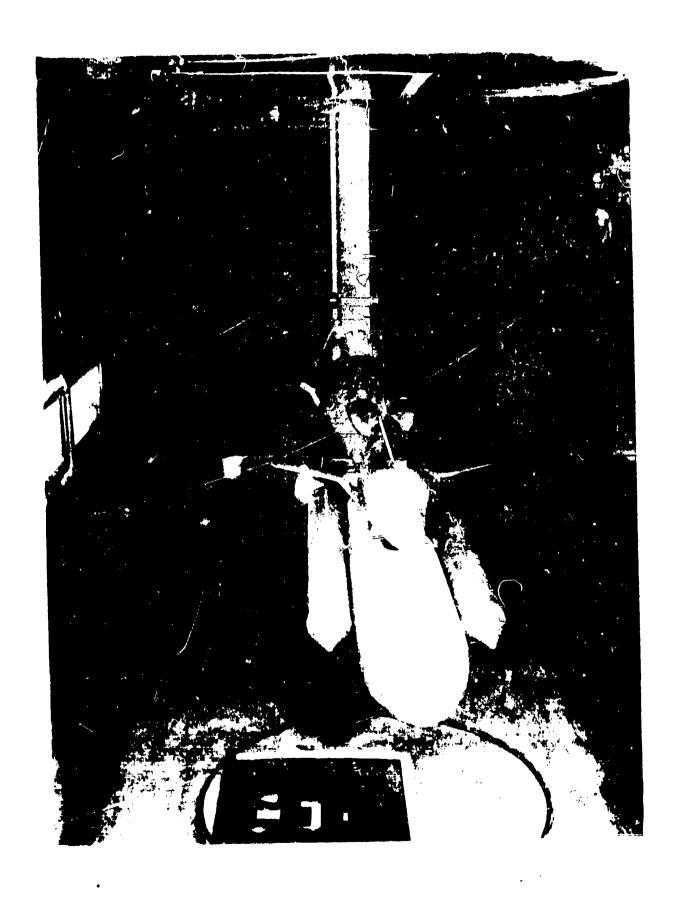
Edgure 2. - Model Sketches.



b. SRM, S₃, and External Tank, T₉
Figure 2. - Continued.



c. Integrated Vehicle Figure 2. - Concluded.

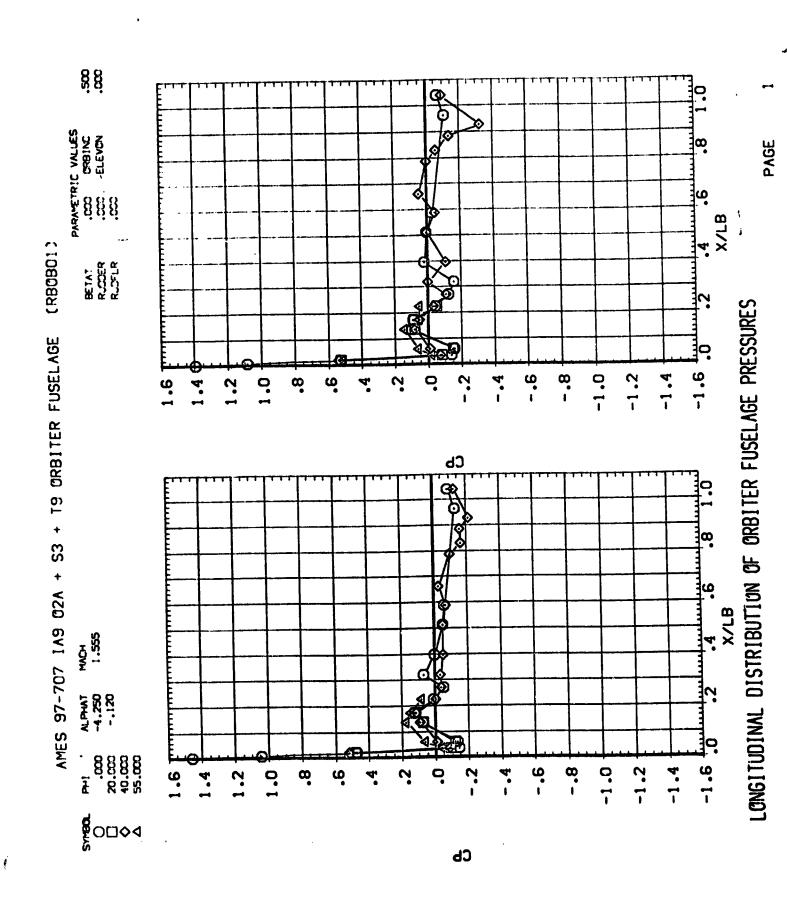


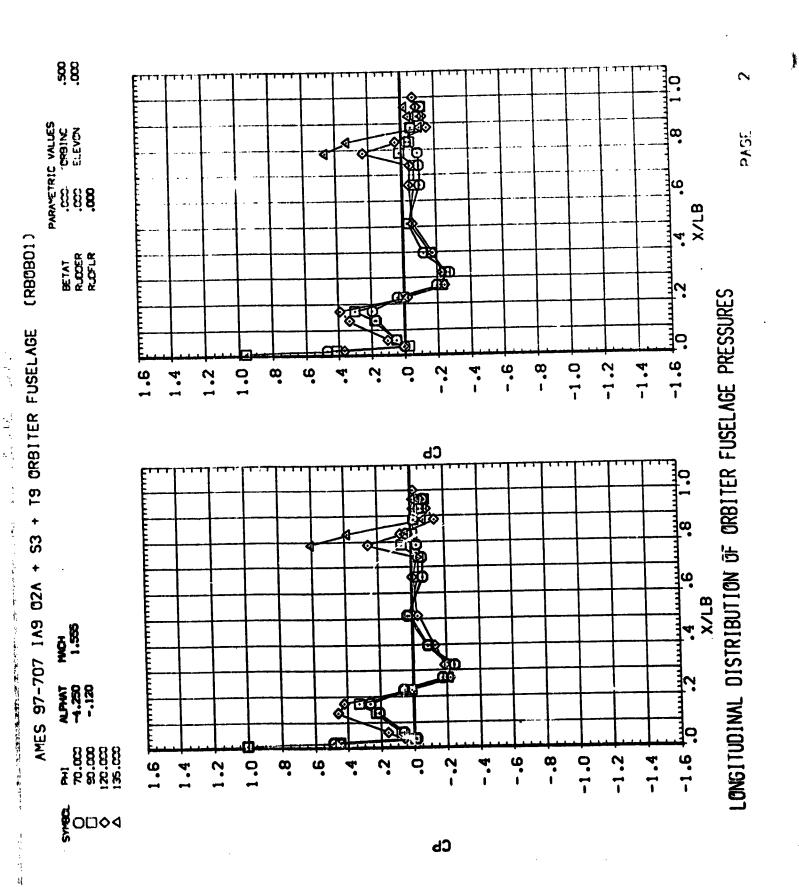


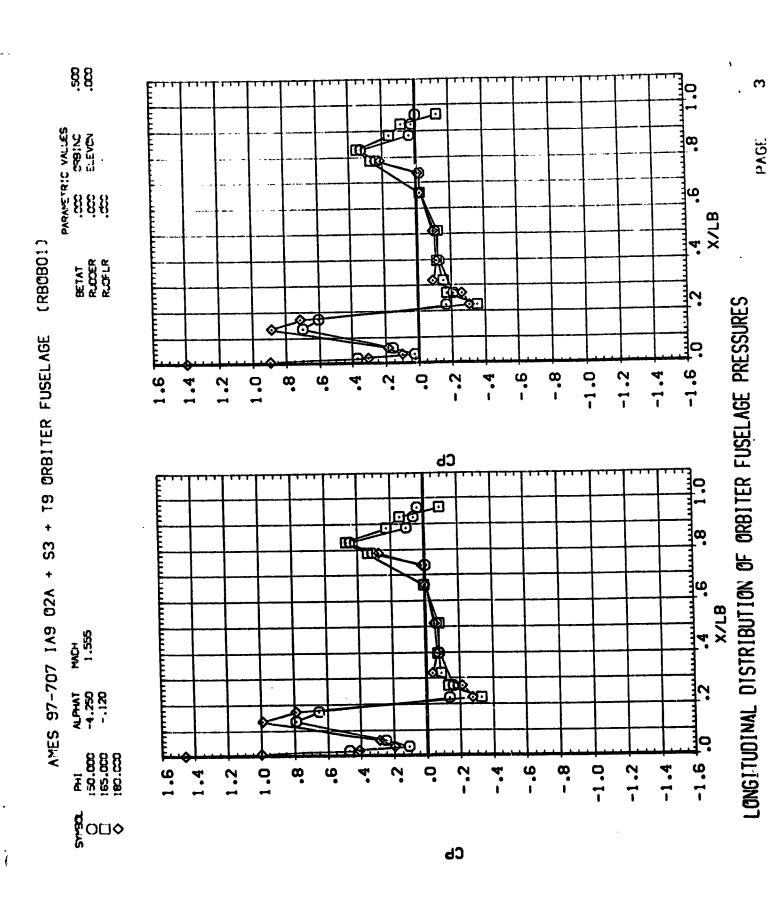
b. Isolated Orbiter (Entry Configuration) Mounted in the ARC 8x7 Ft. Tunnel Hgure 3. - Concluded.

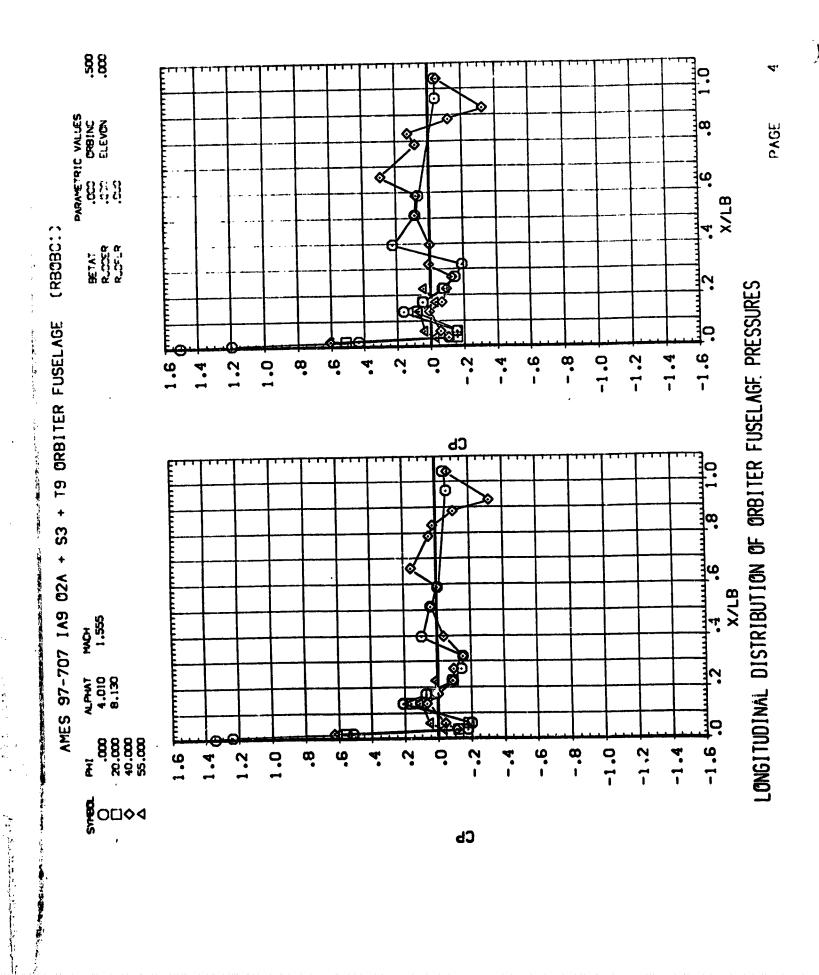
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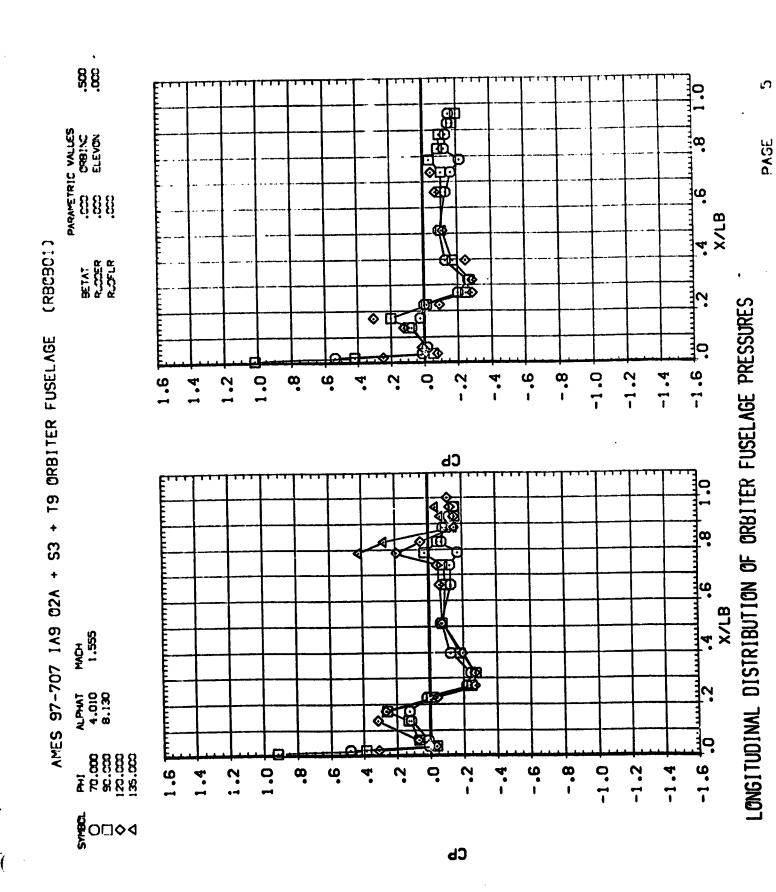
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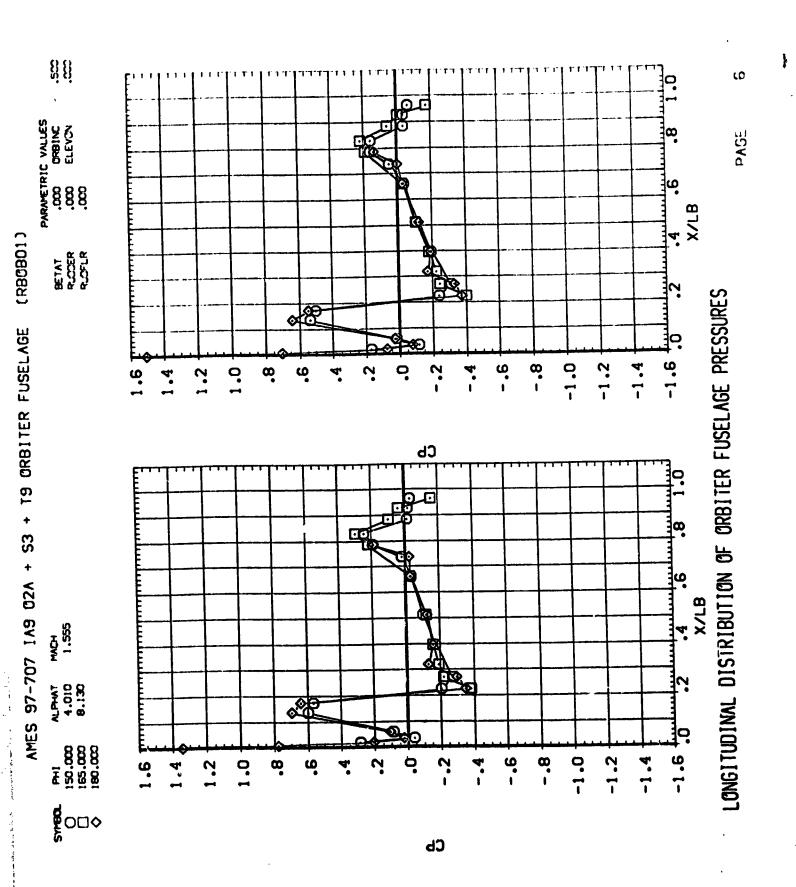


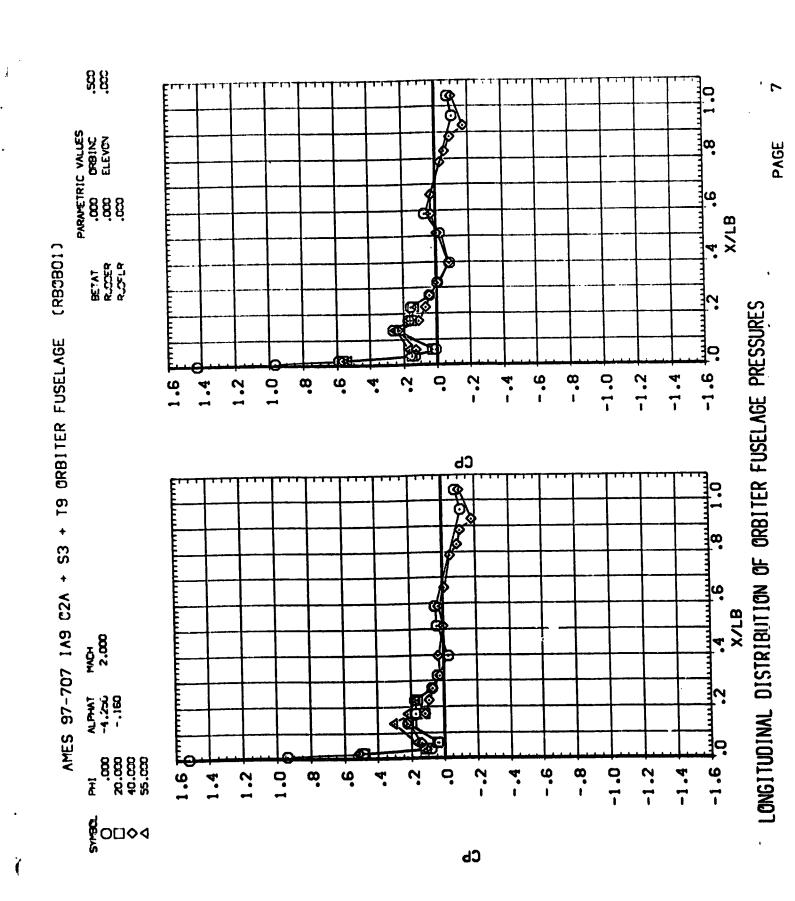




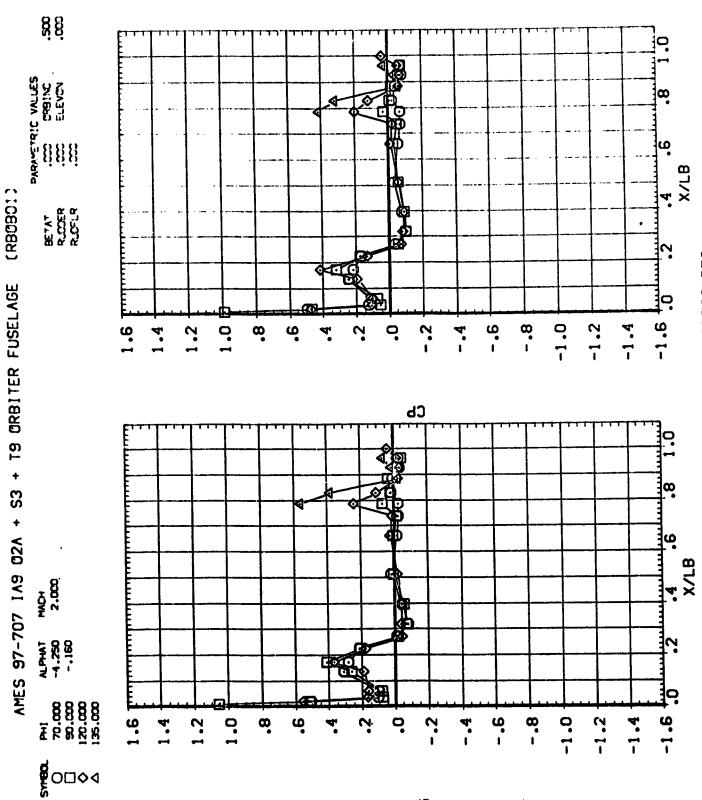






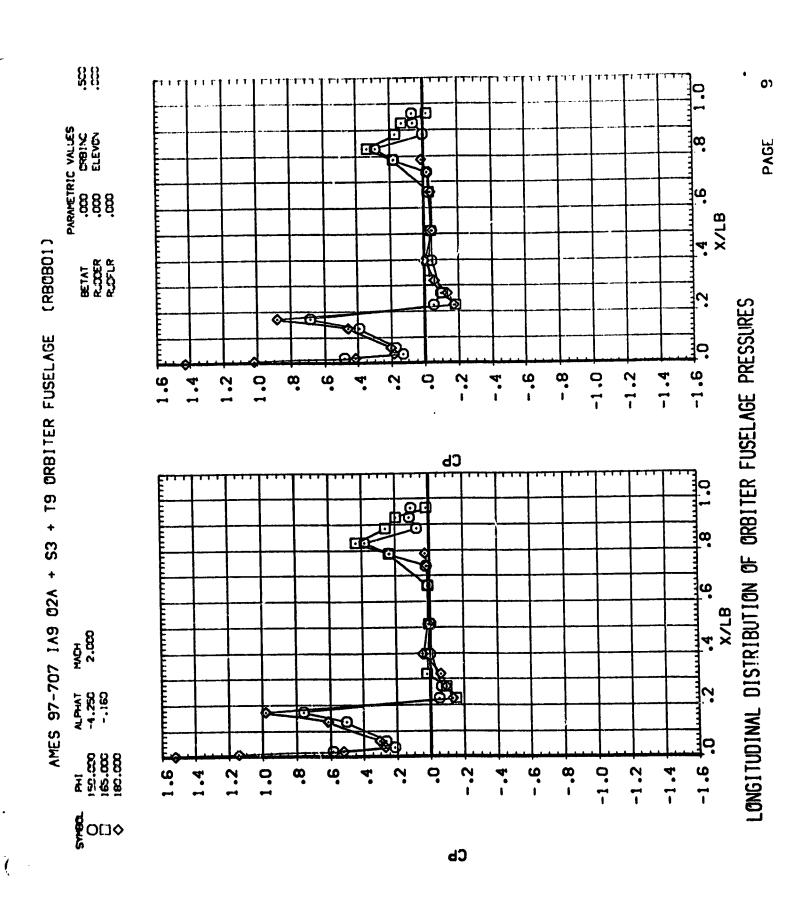


以を持つというできた計算機器は開発される。可能性の特殊を持ち

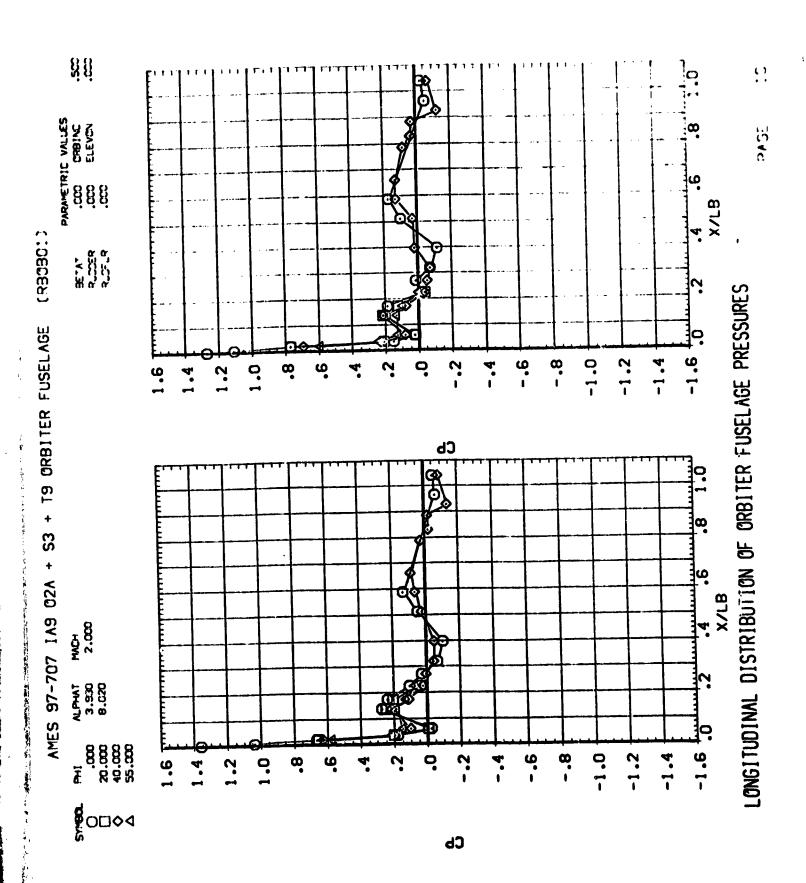


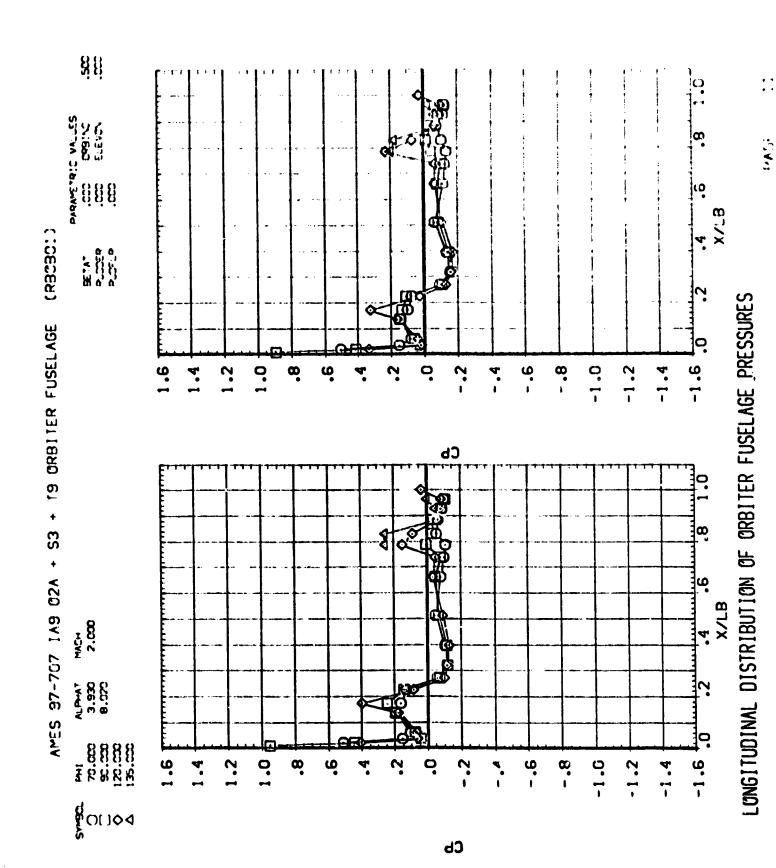
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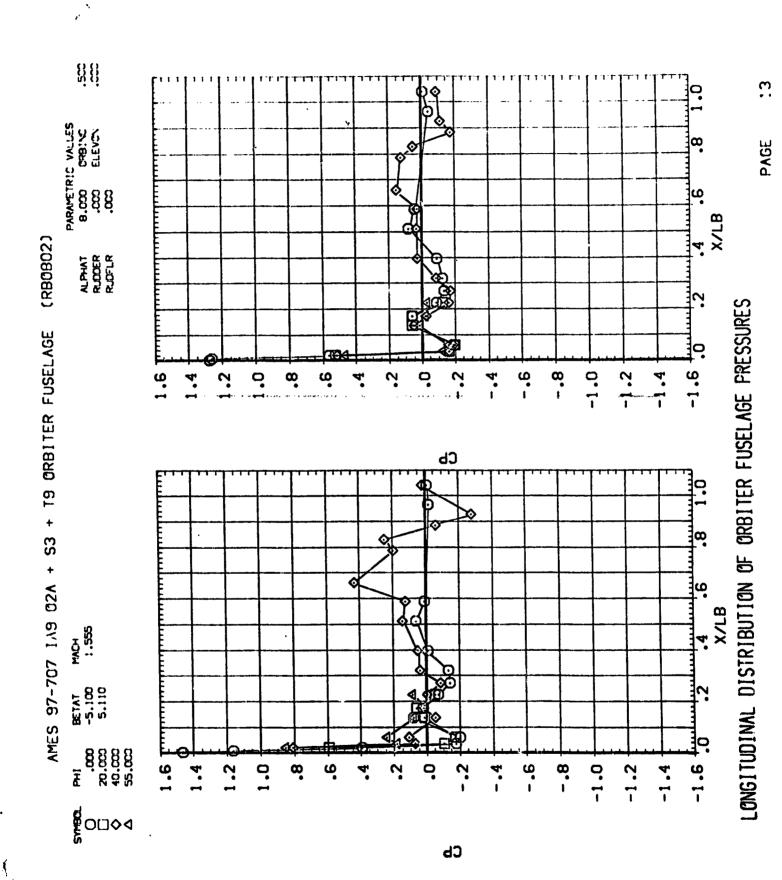




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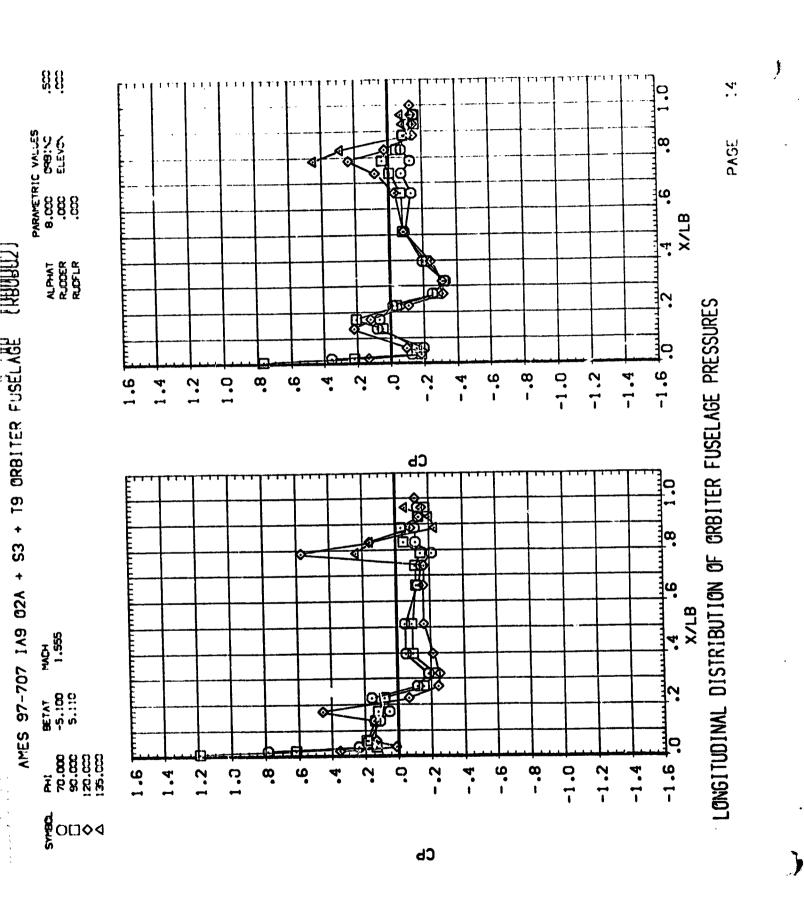


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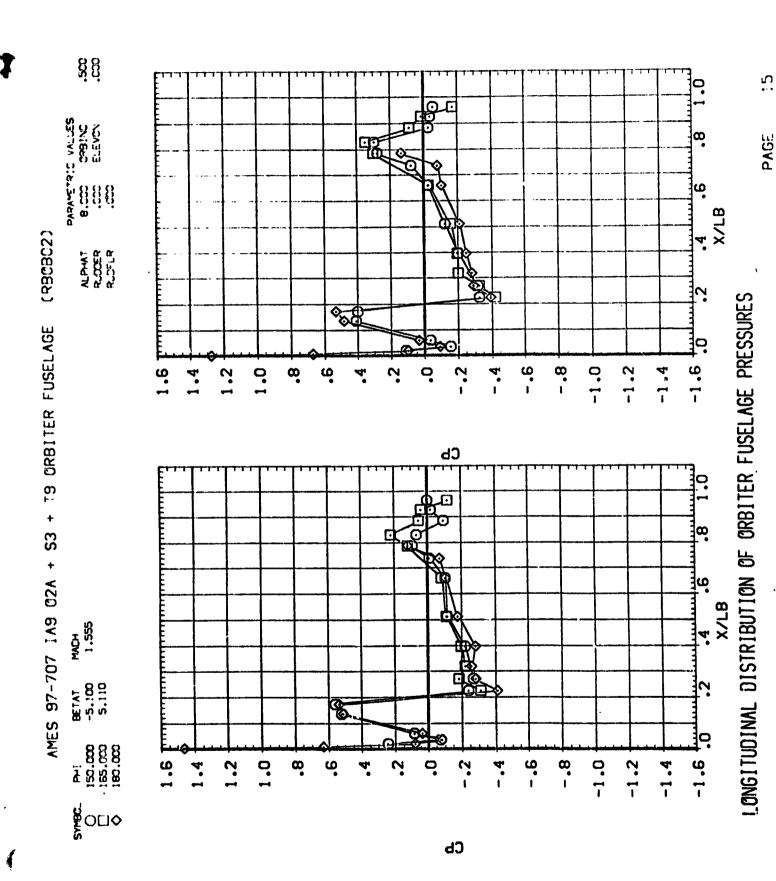
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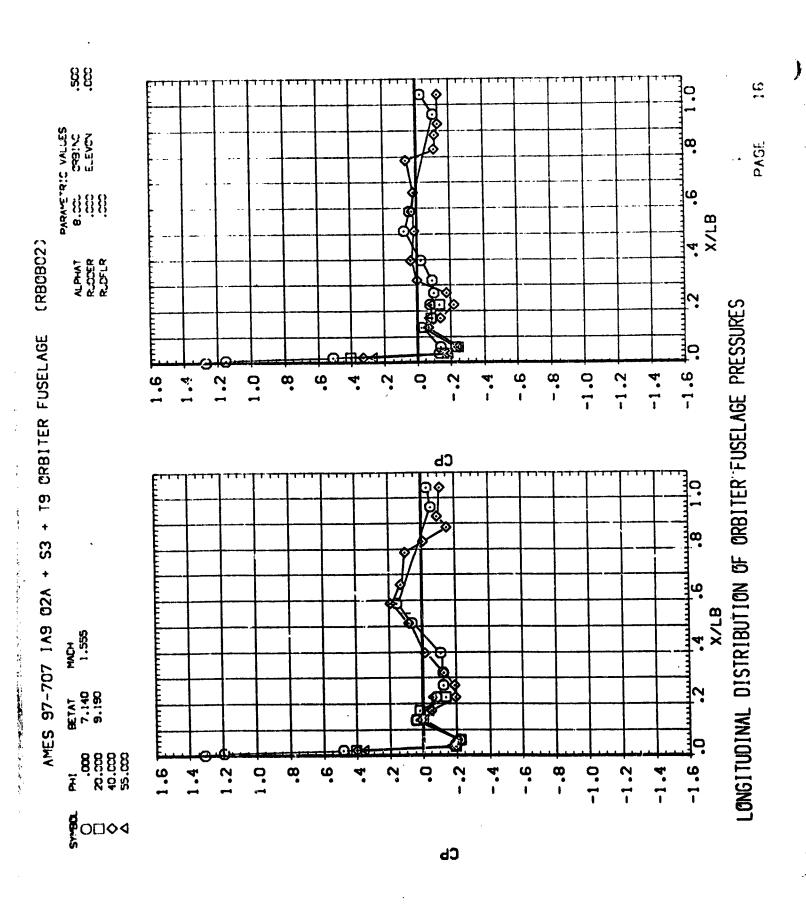
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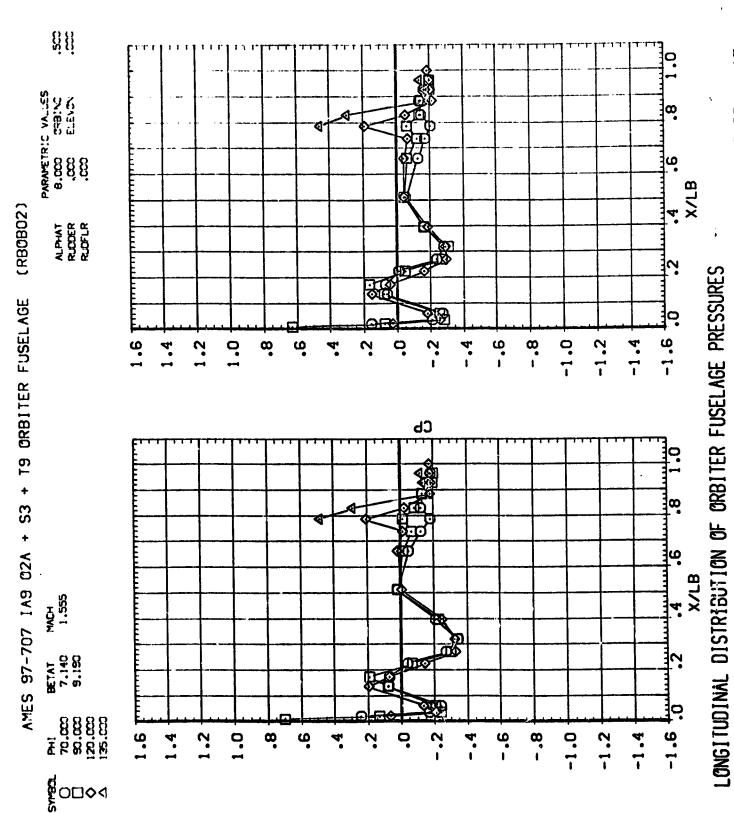
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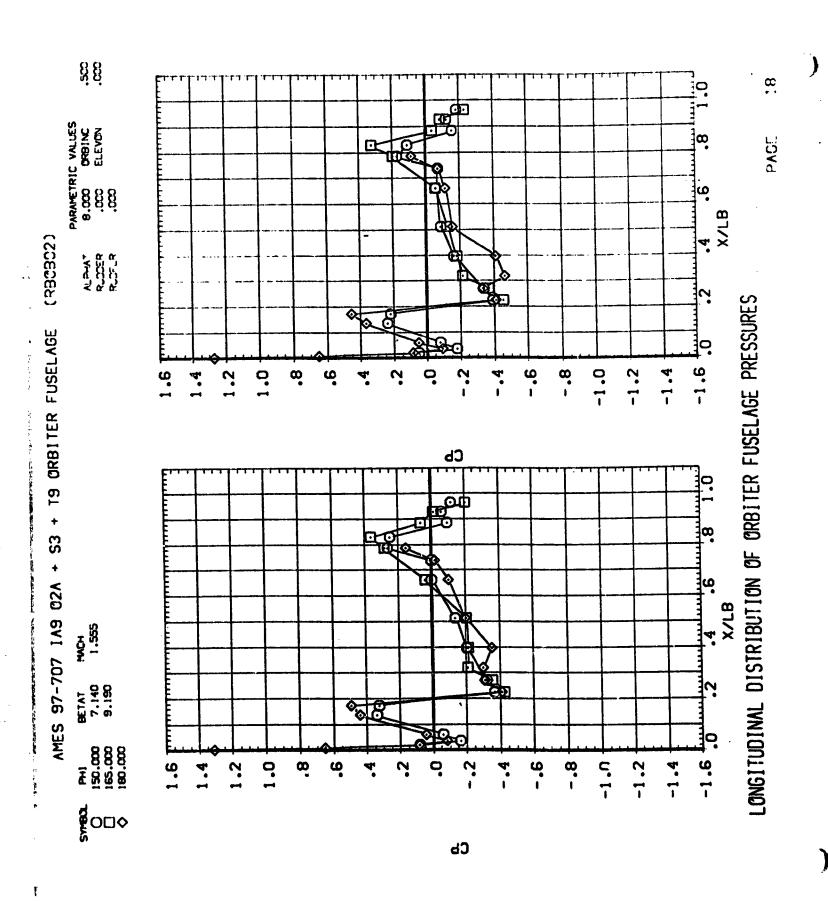
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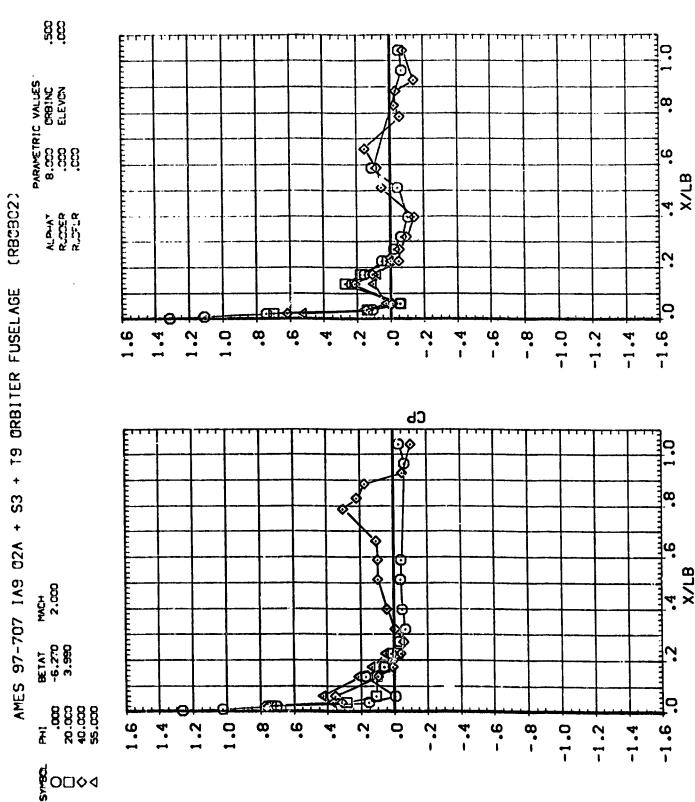






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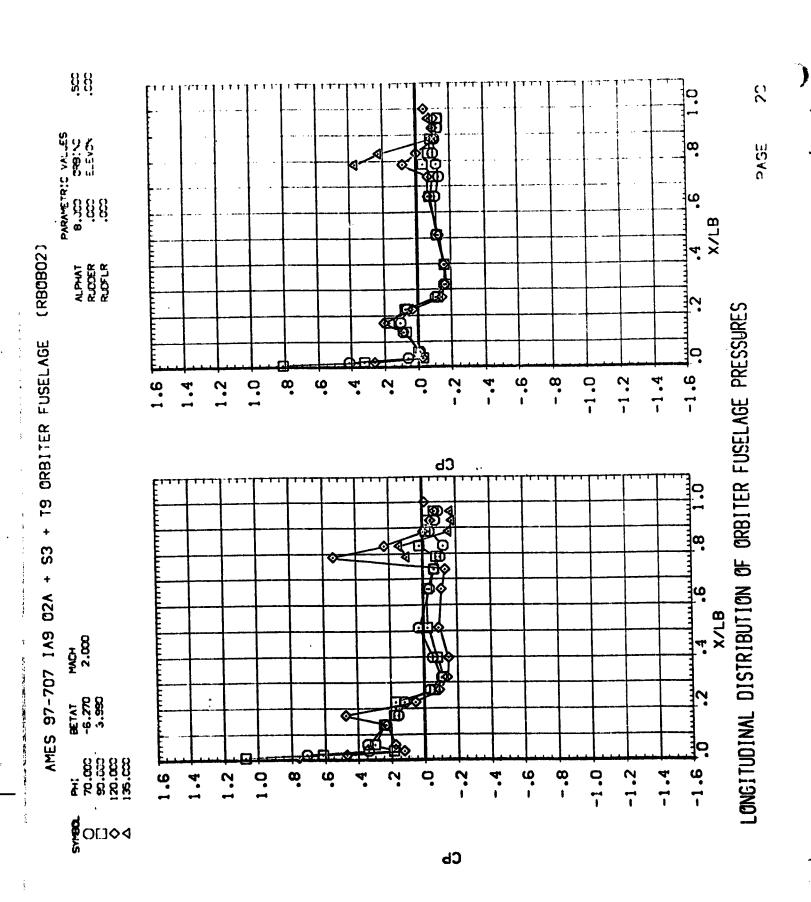
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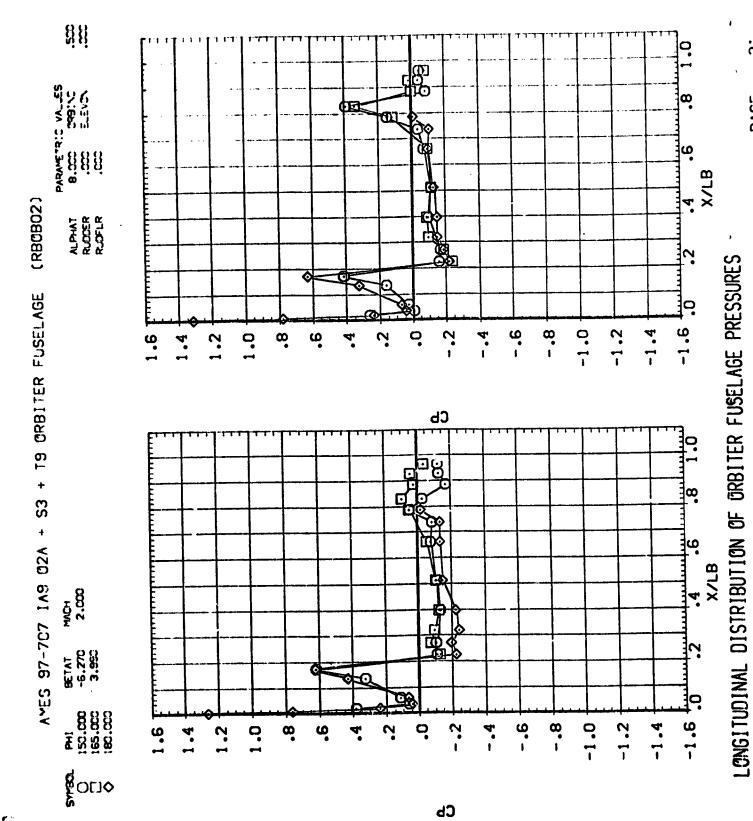
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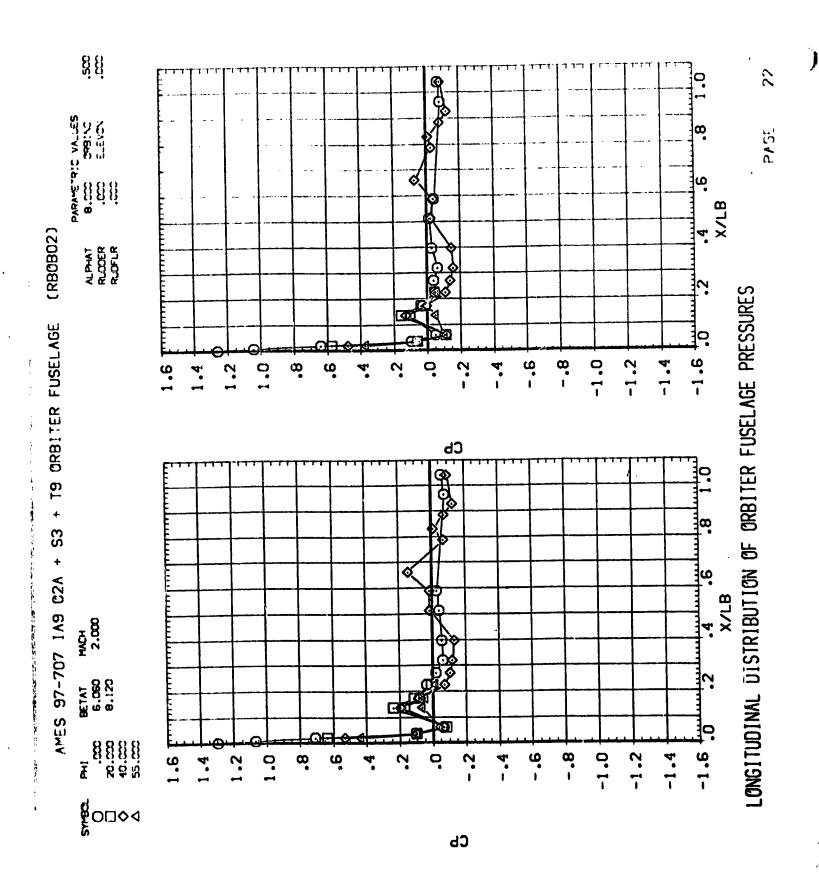
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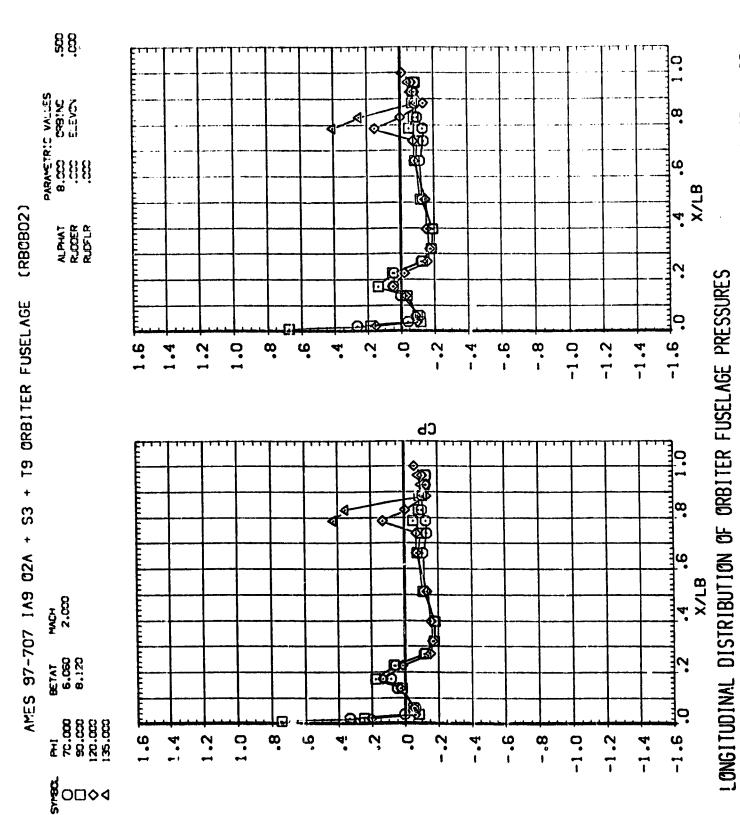
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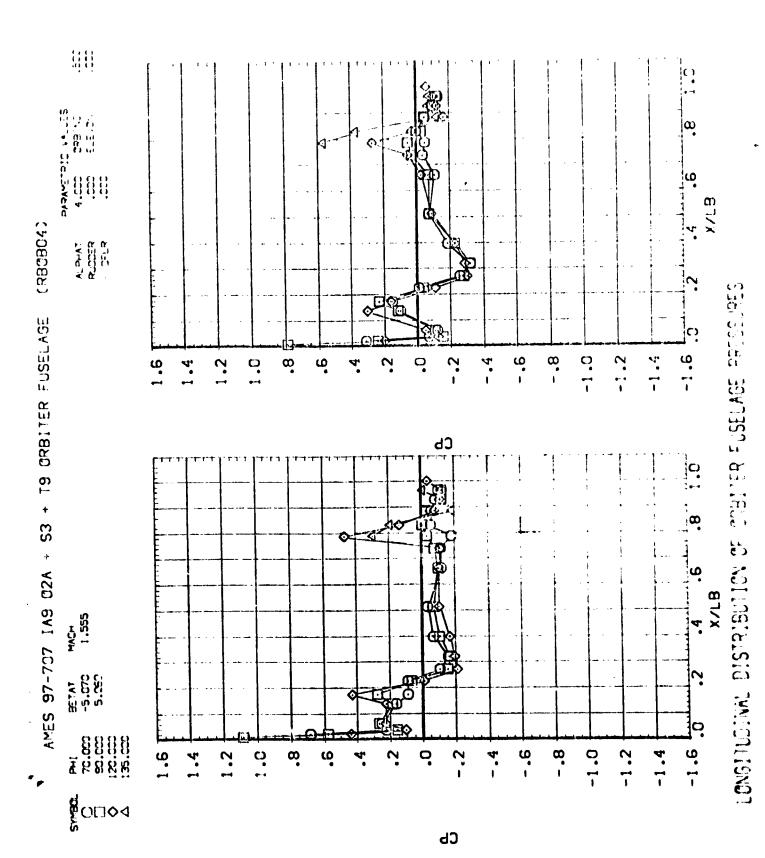
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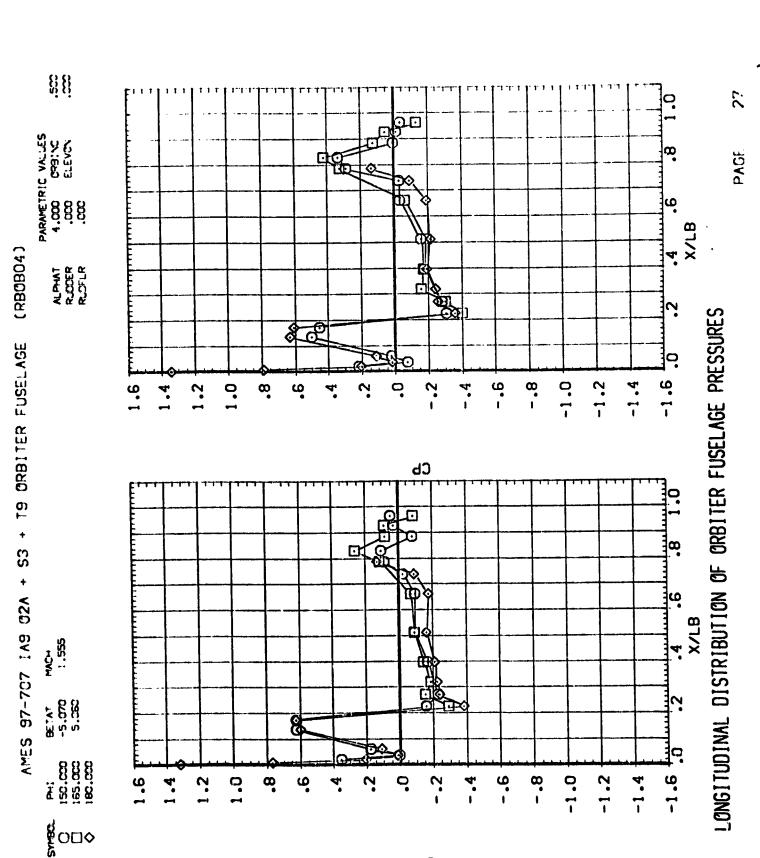
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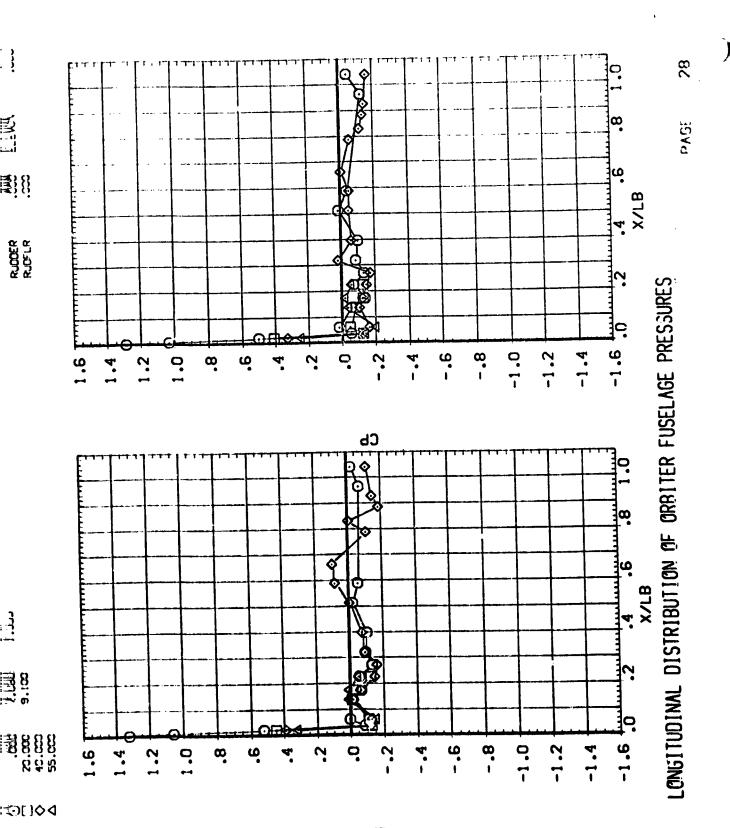
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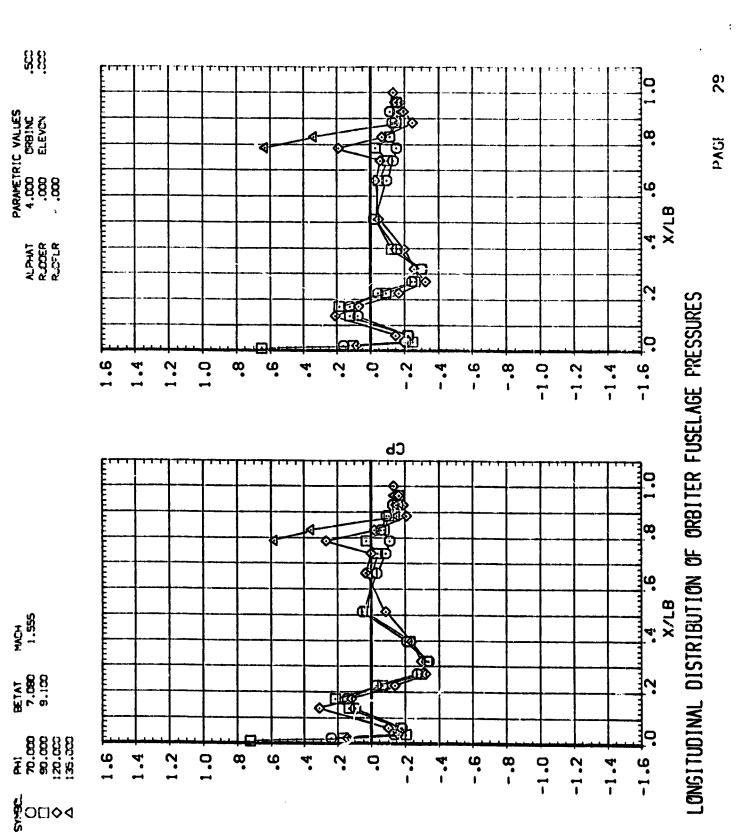
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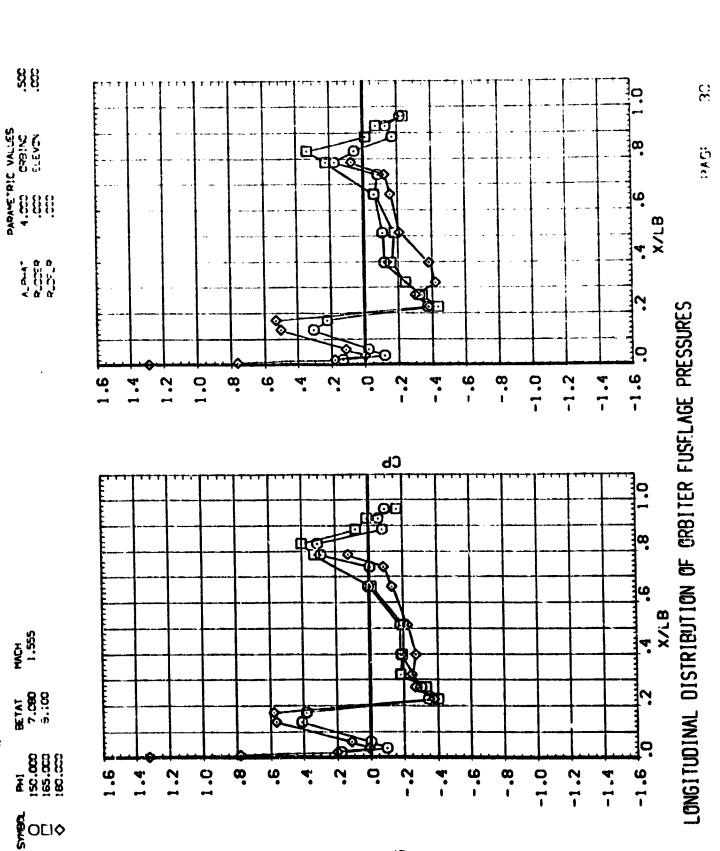




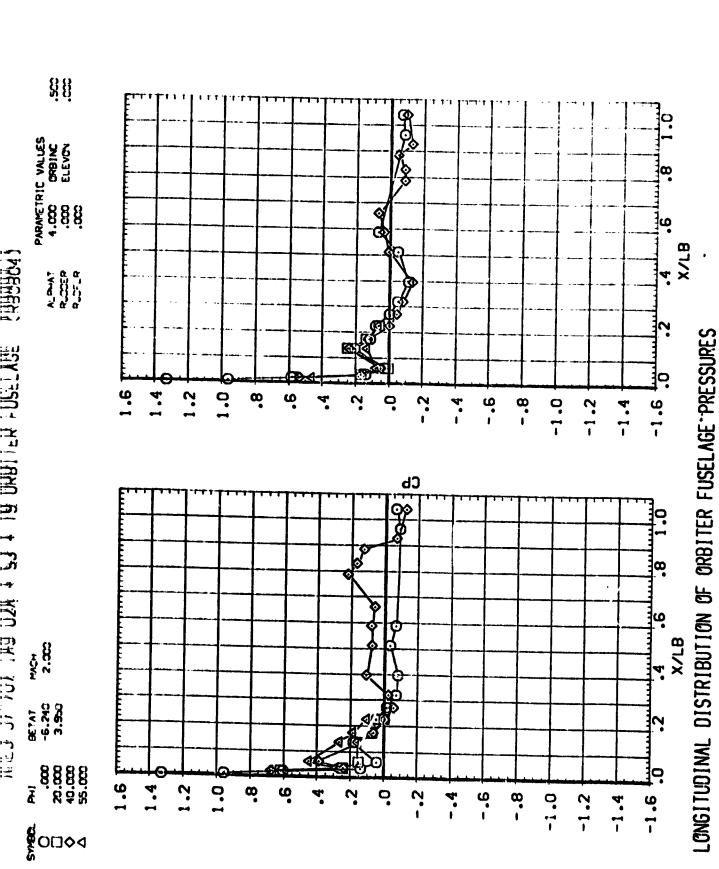


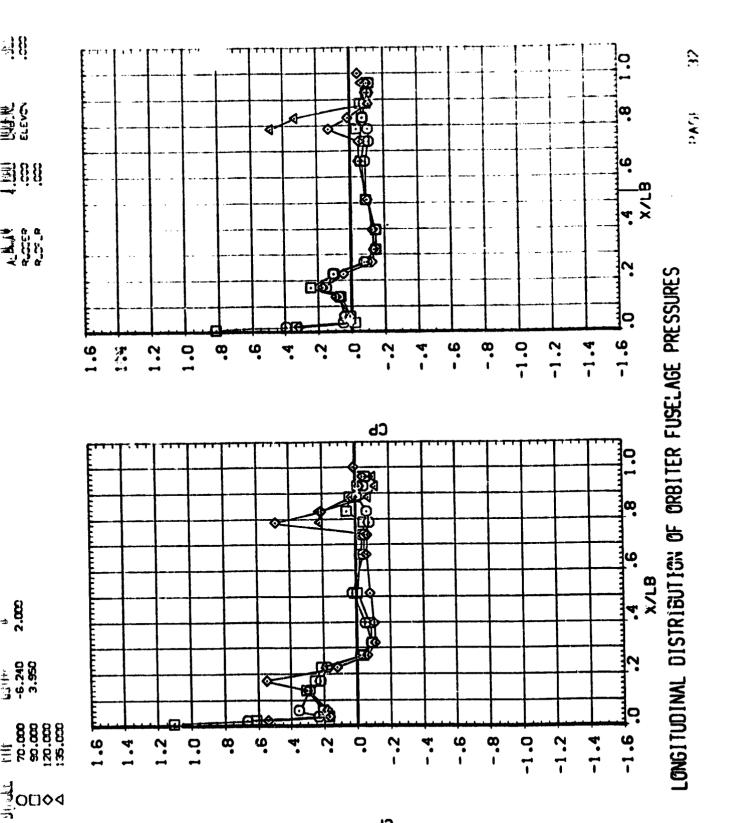


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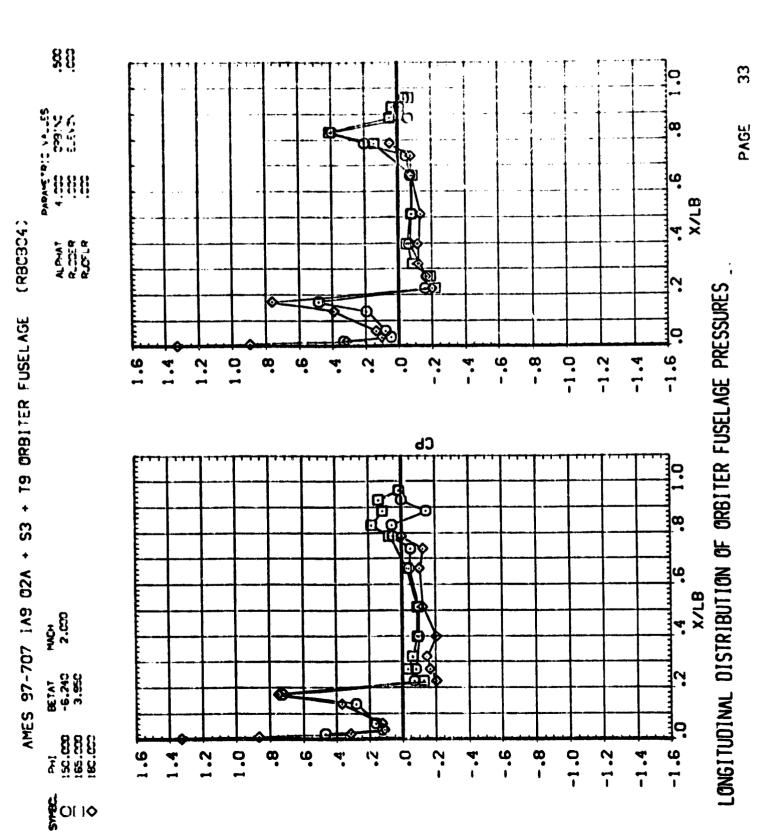
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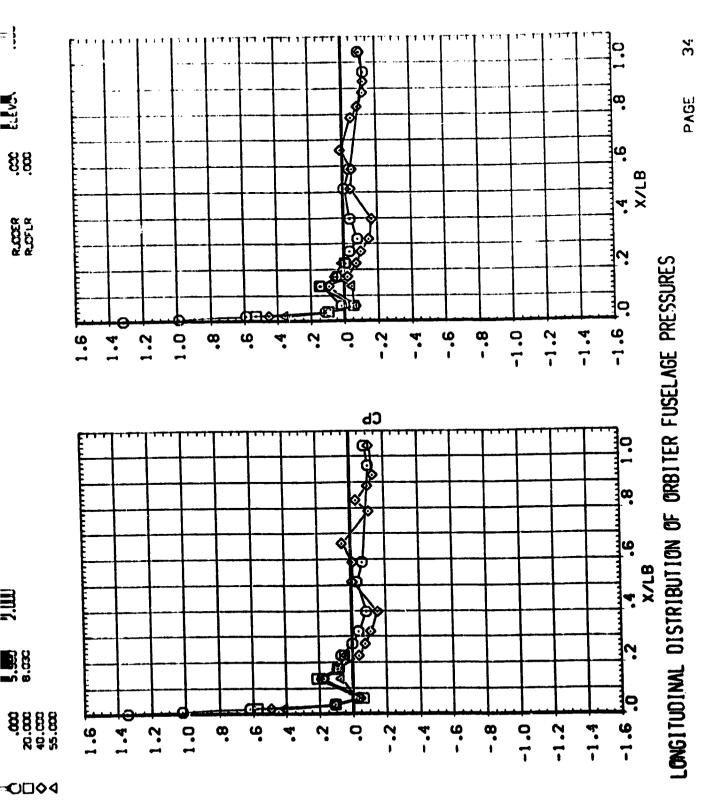




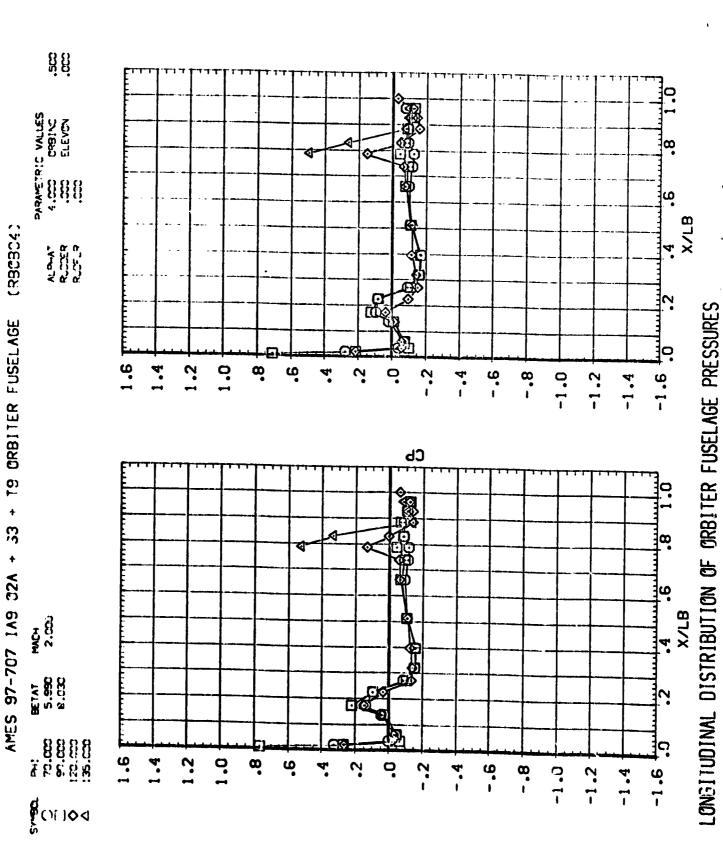
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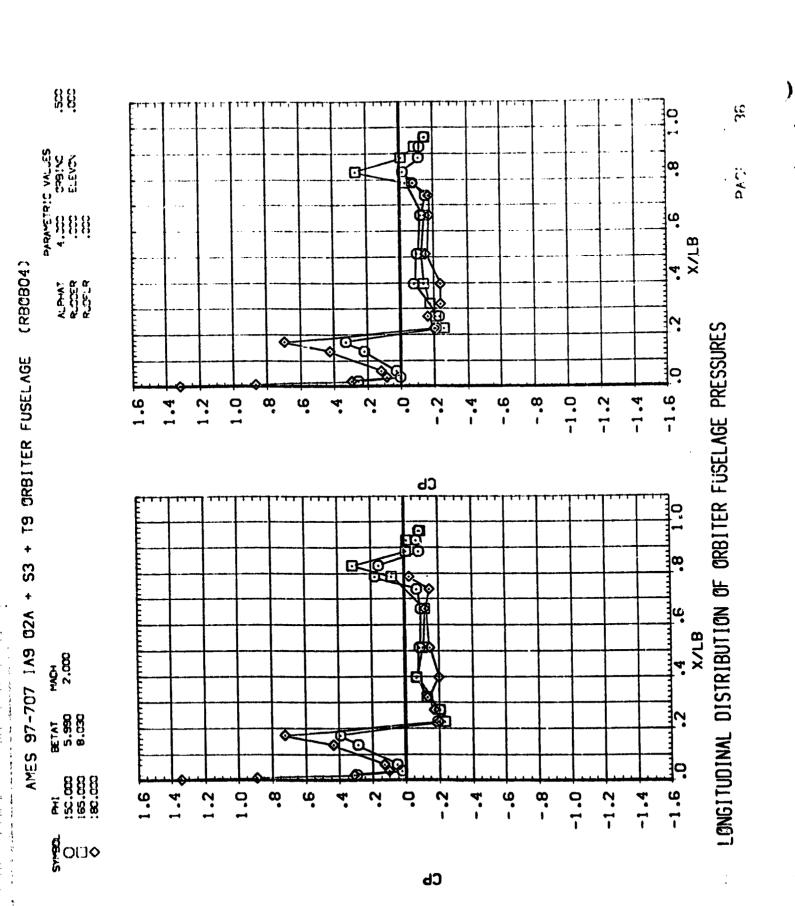
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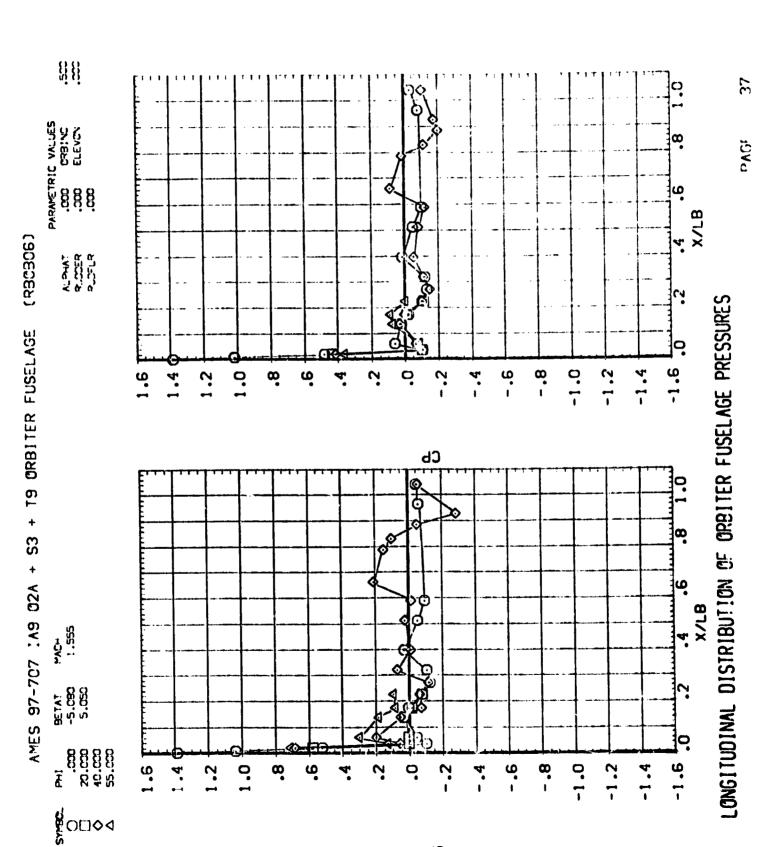




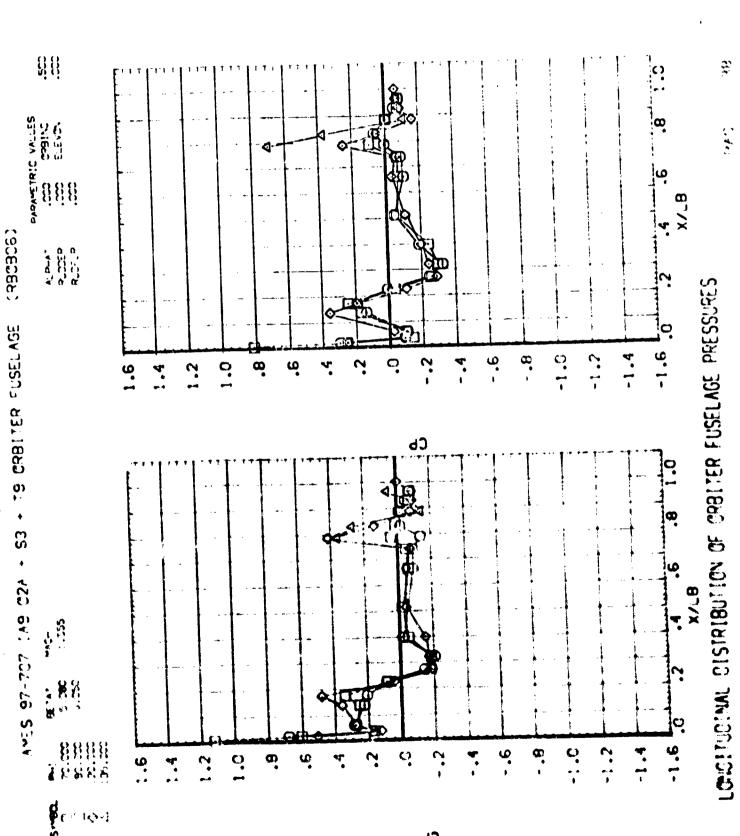
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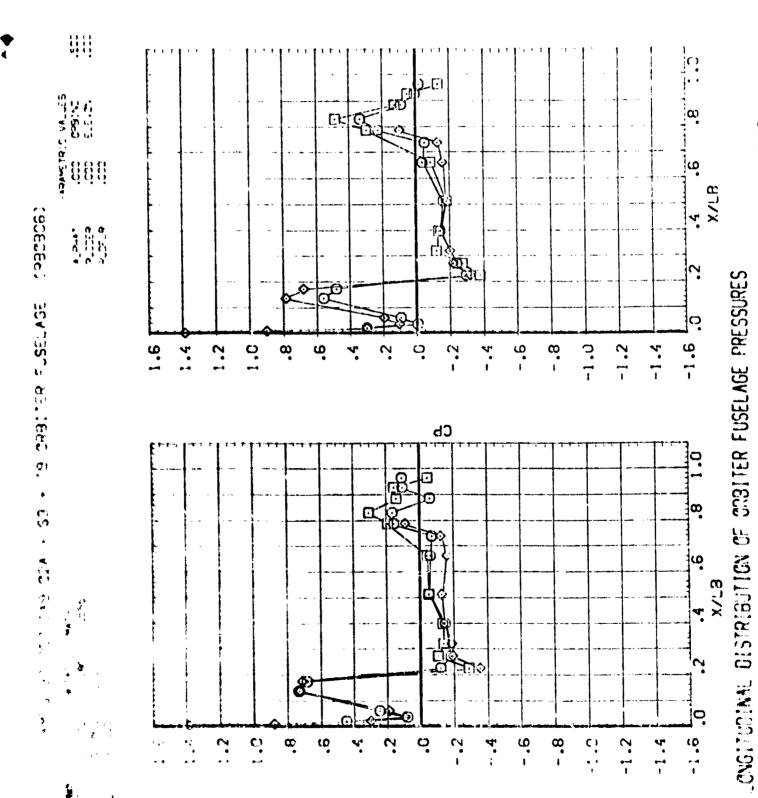


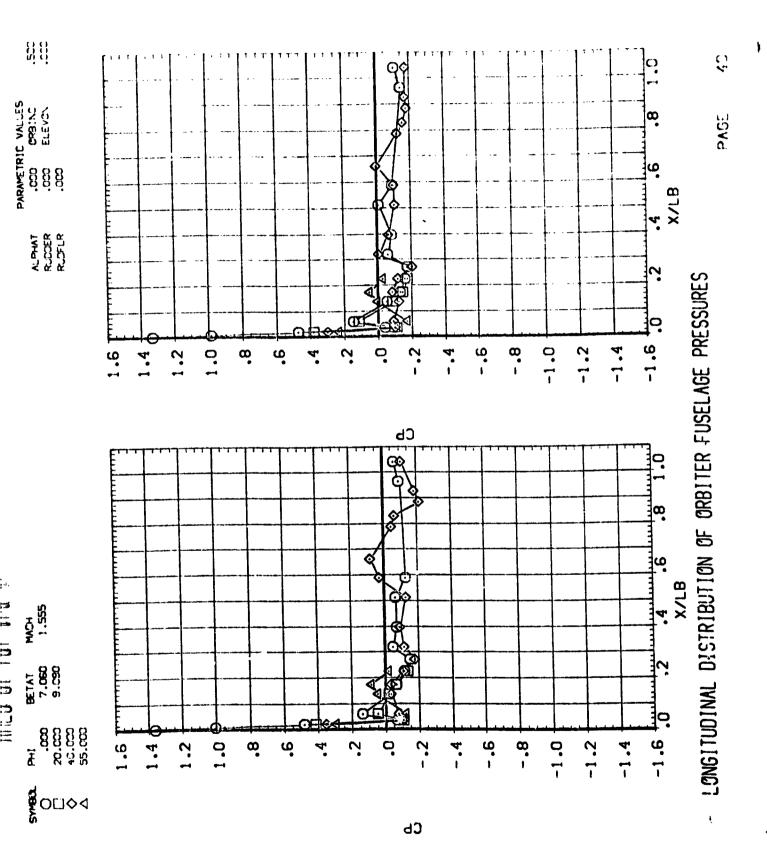


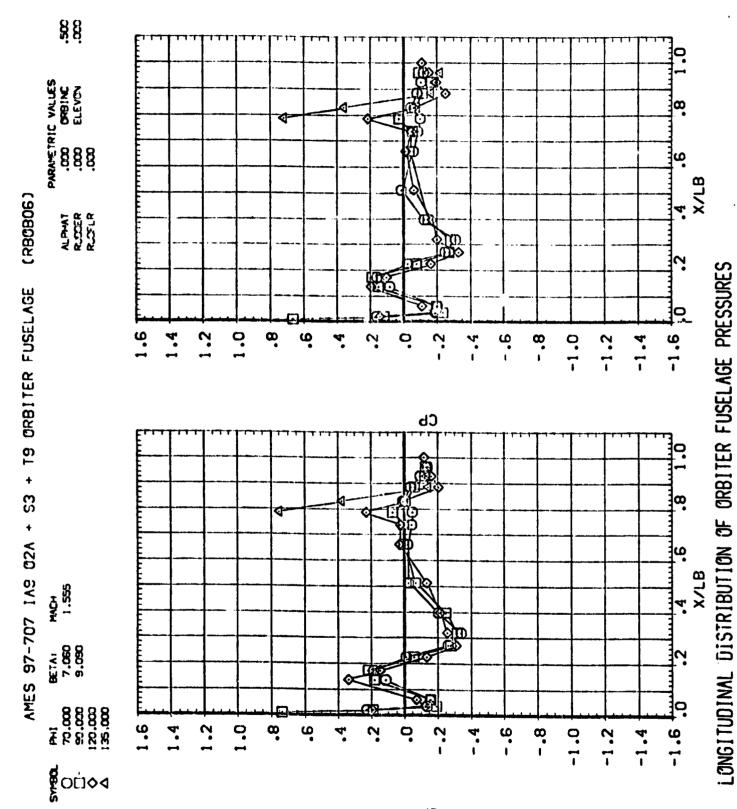


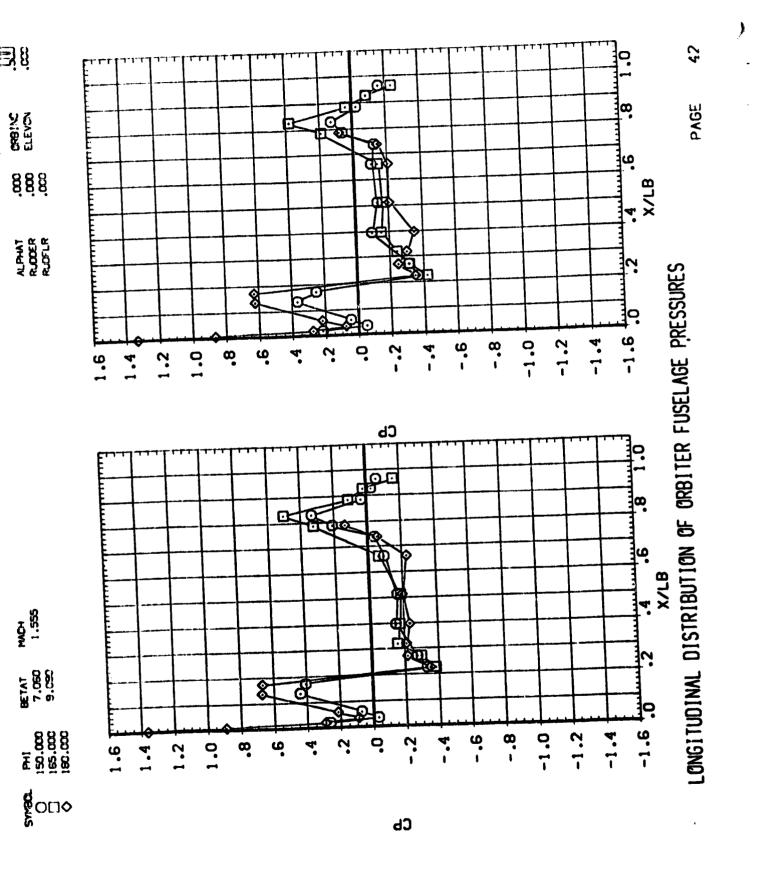
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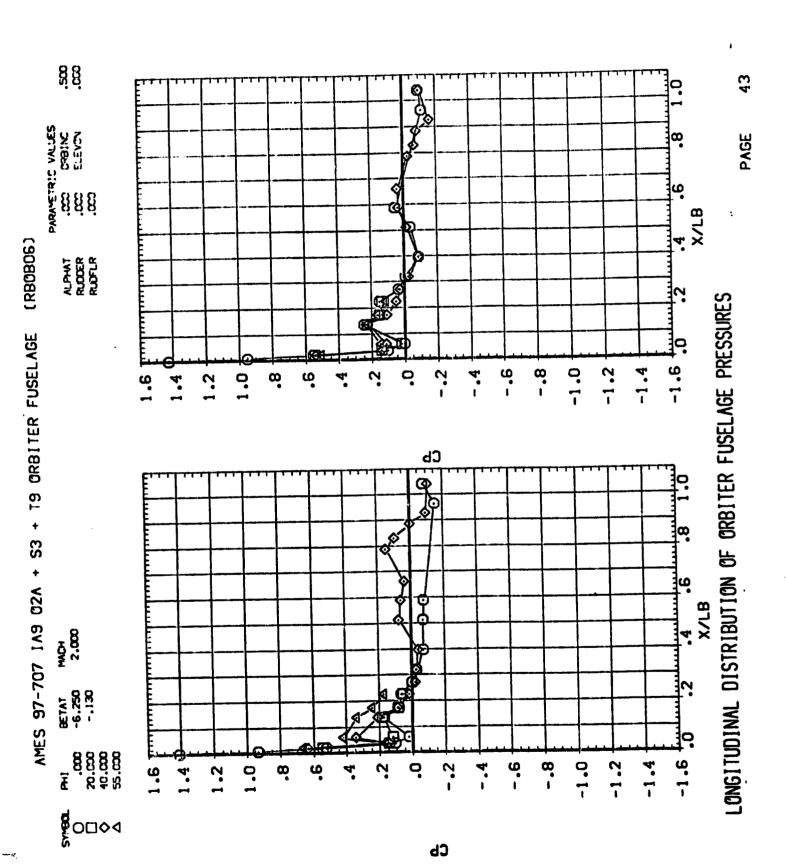




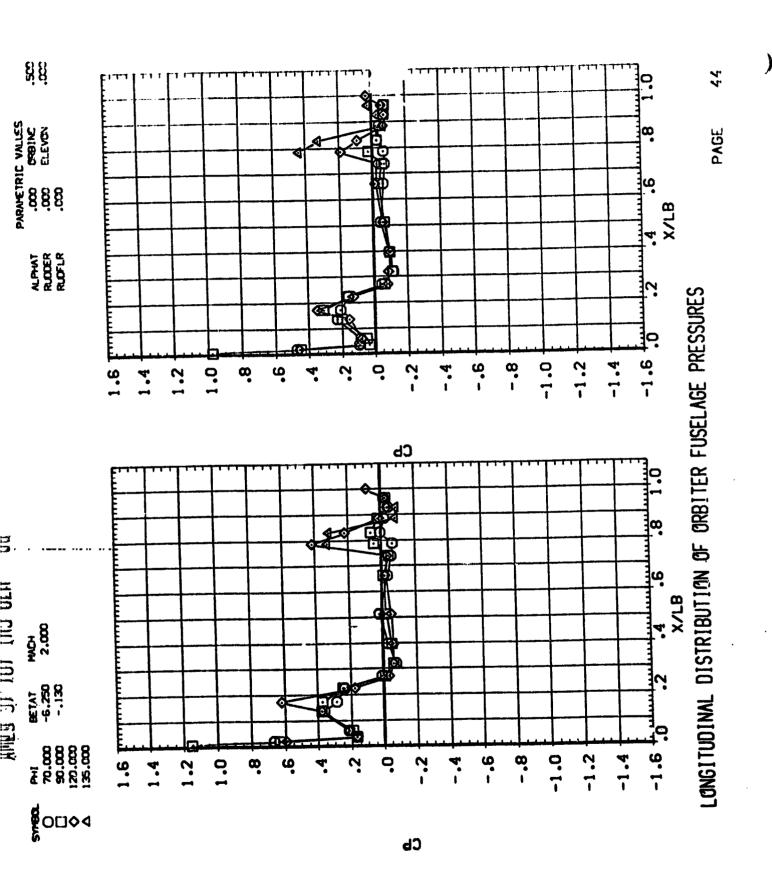




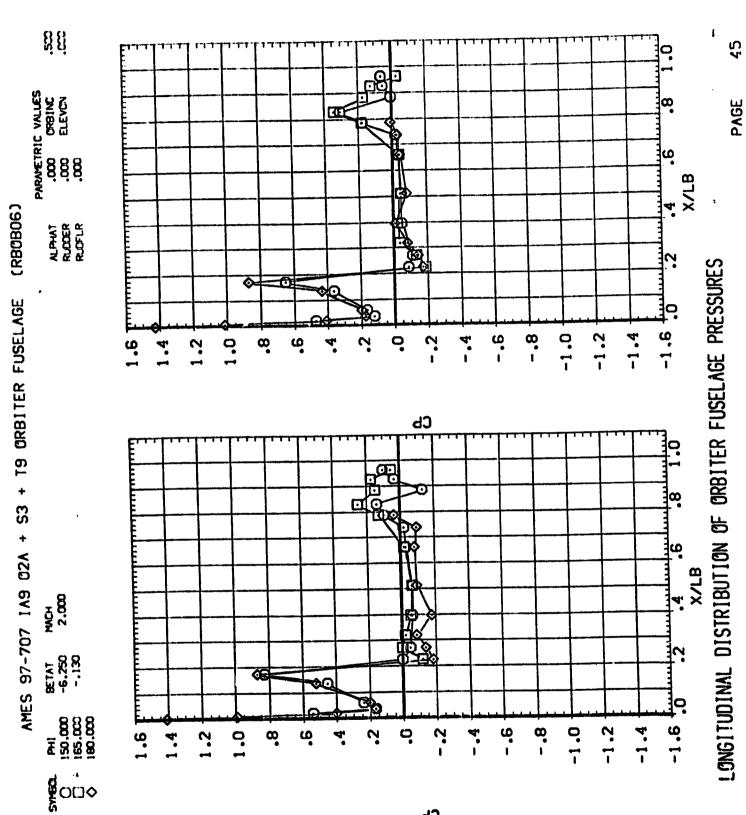




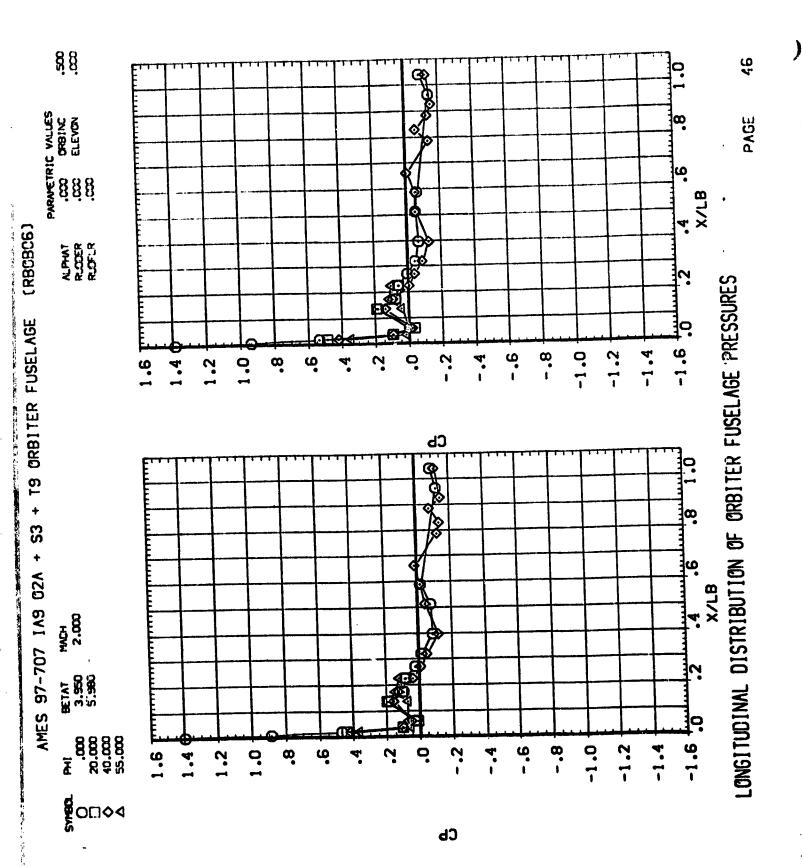
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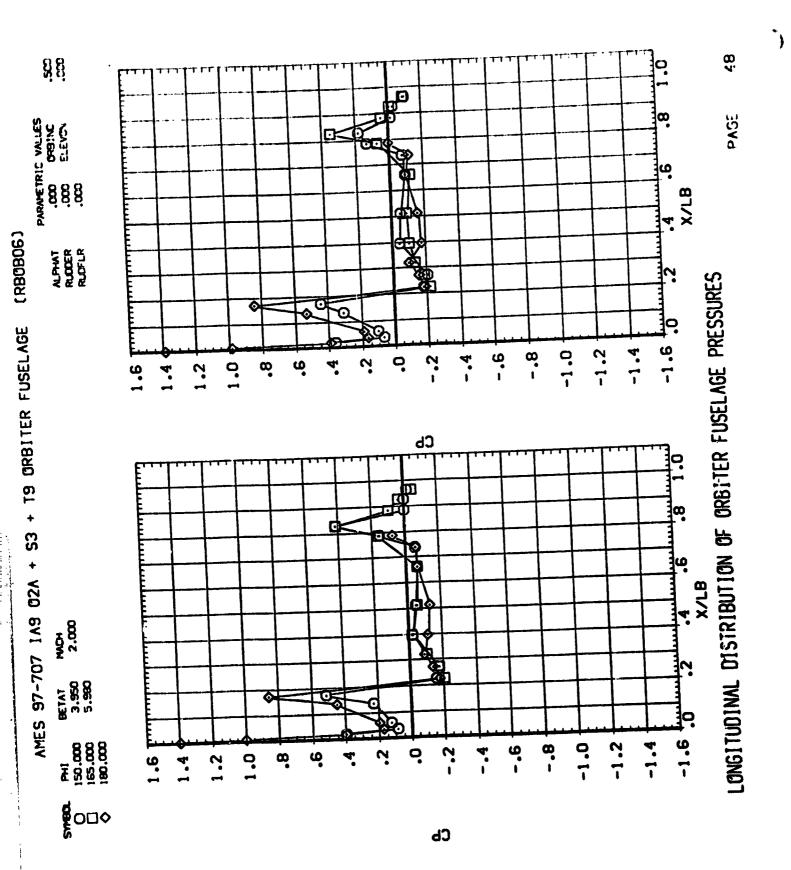
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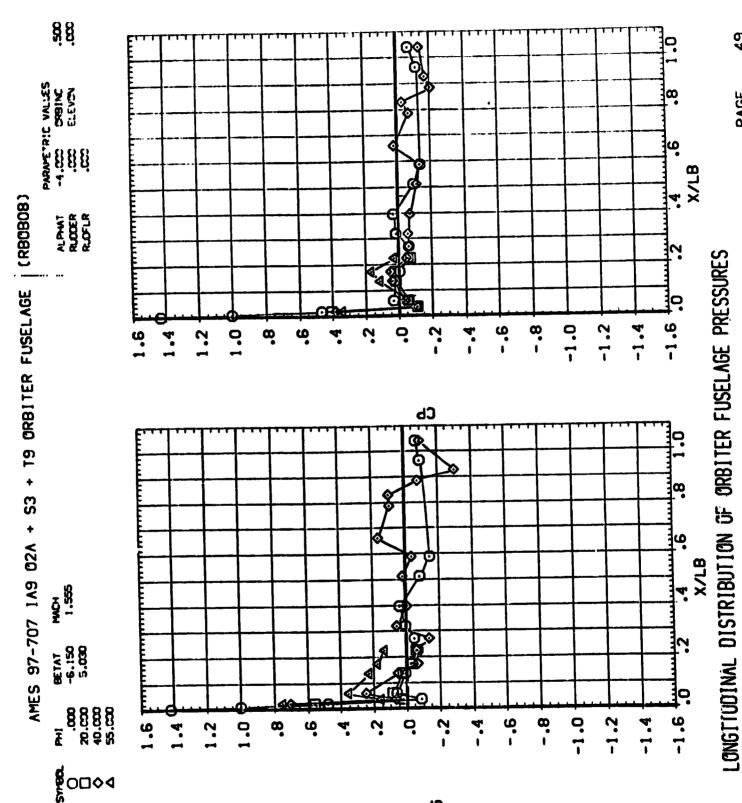
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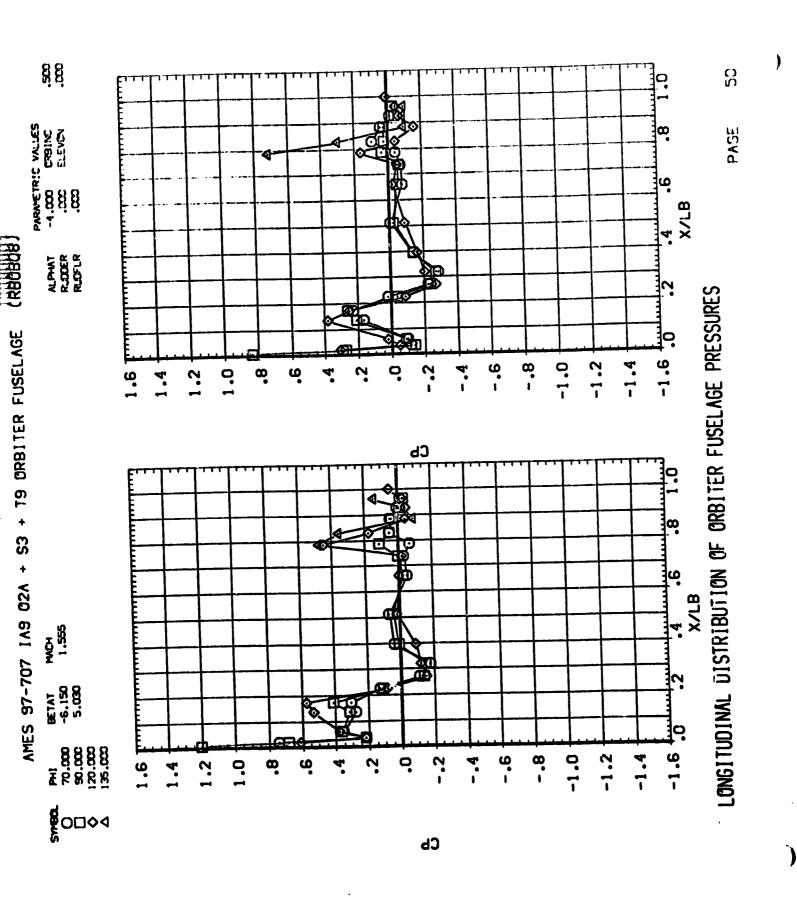


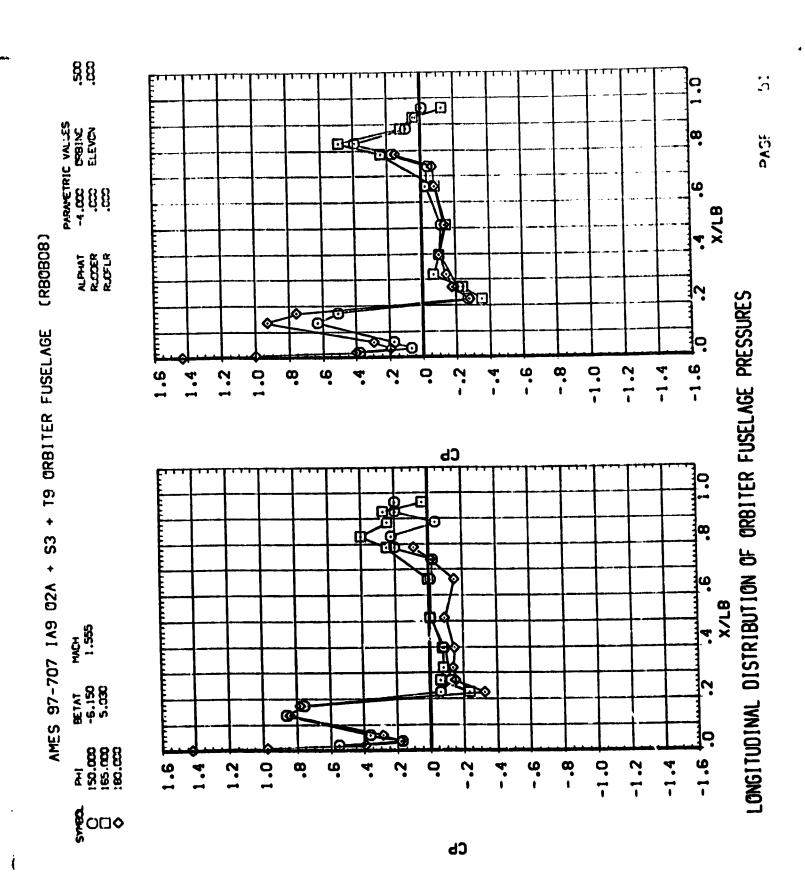
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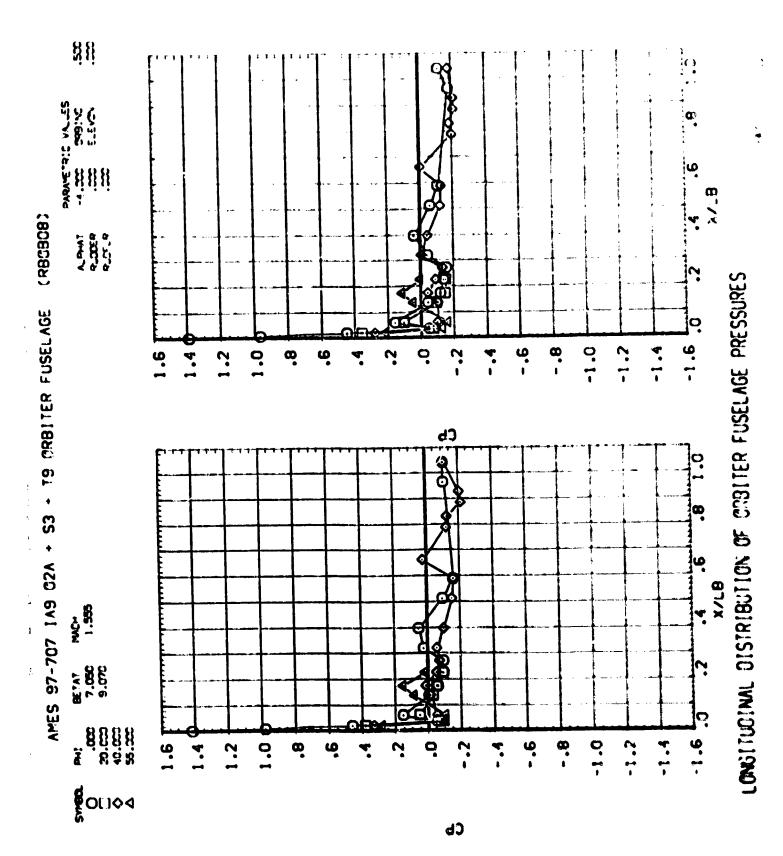


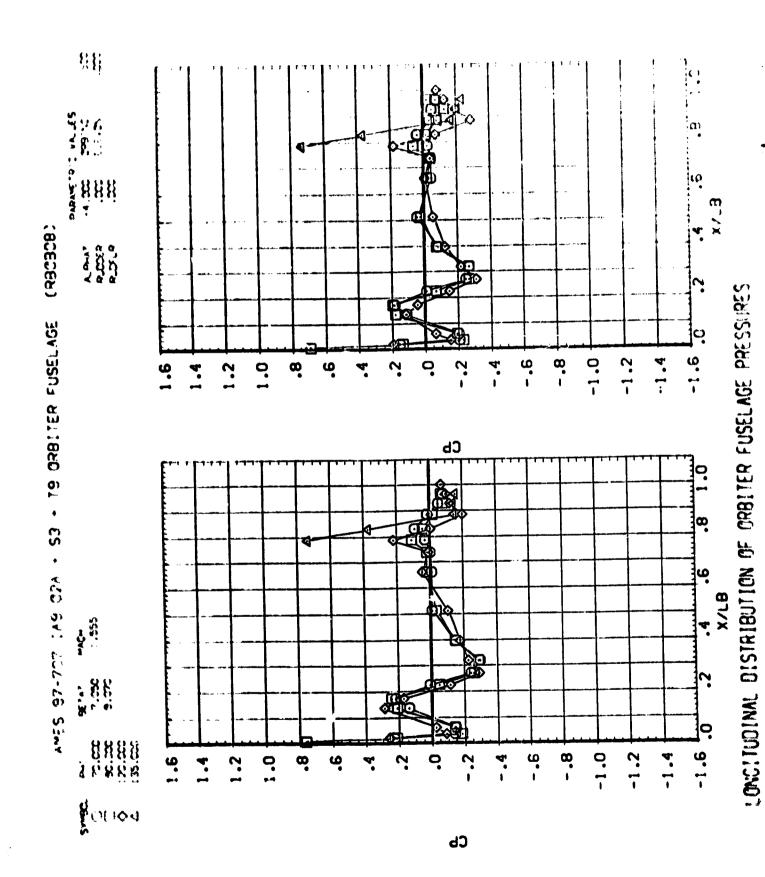
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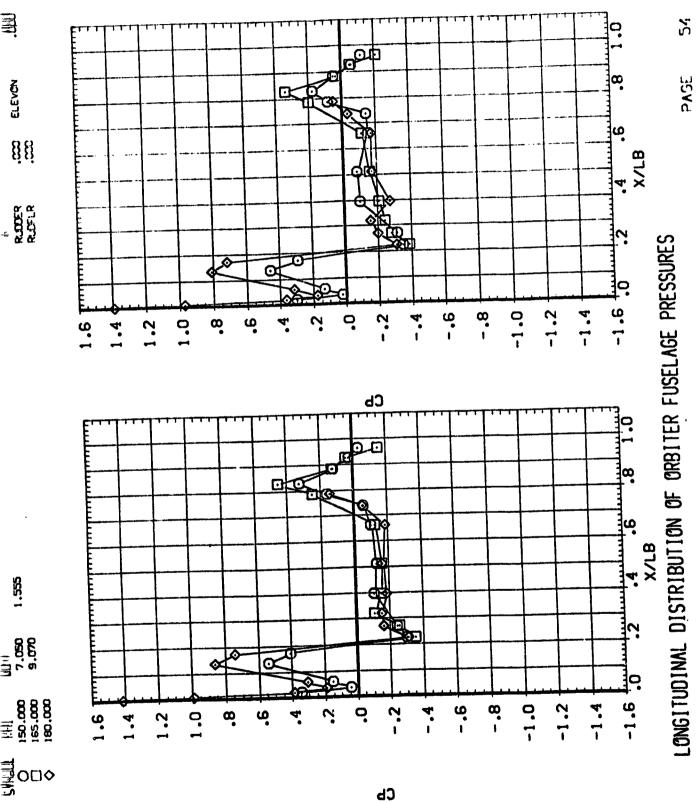


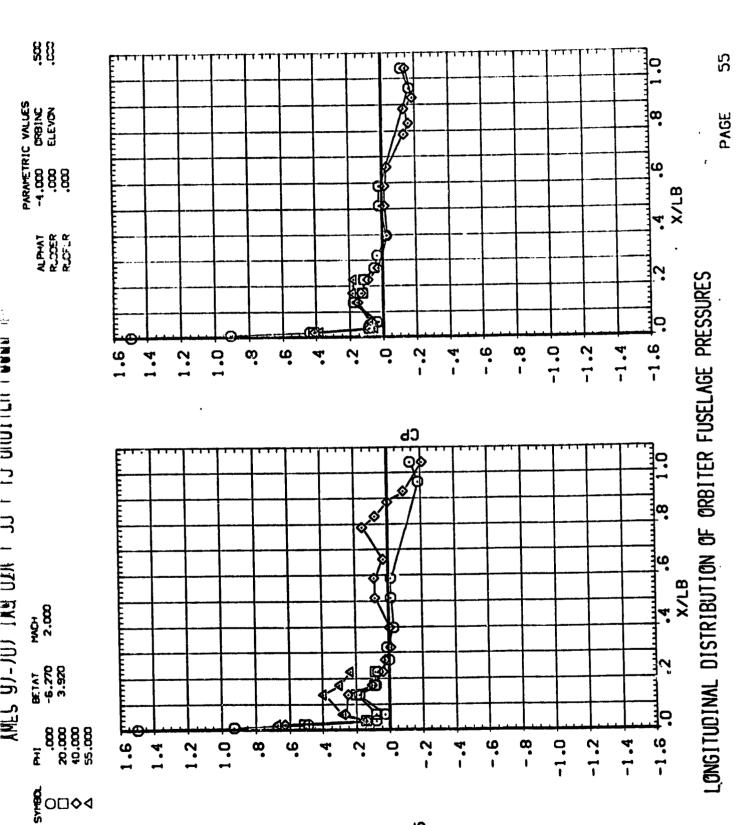


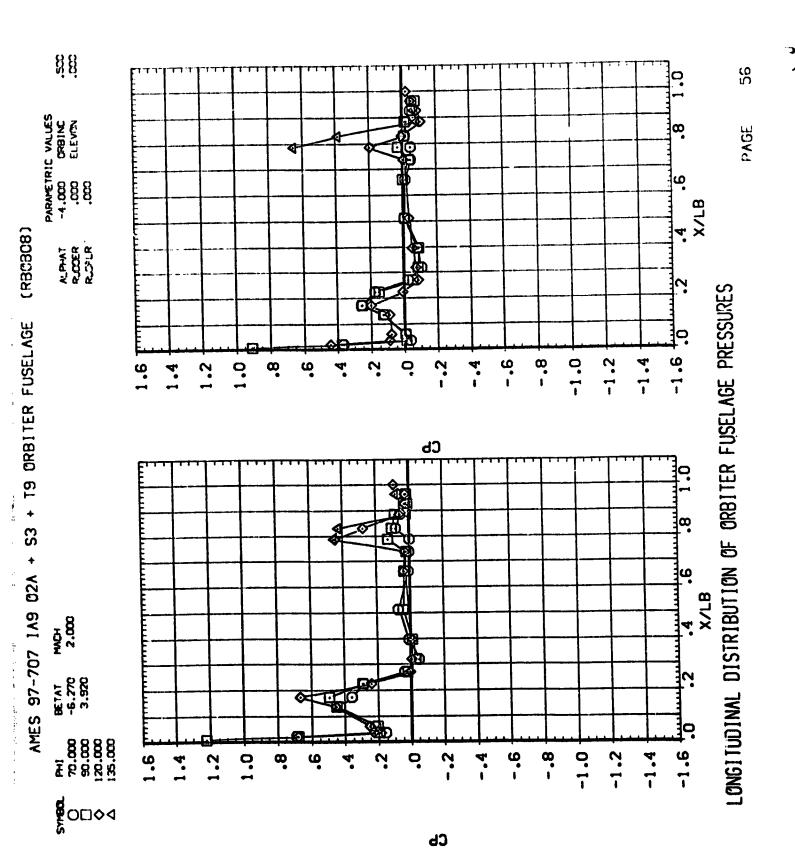


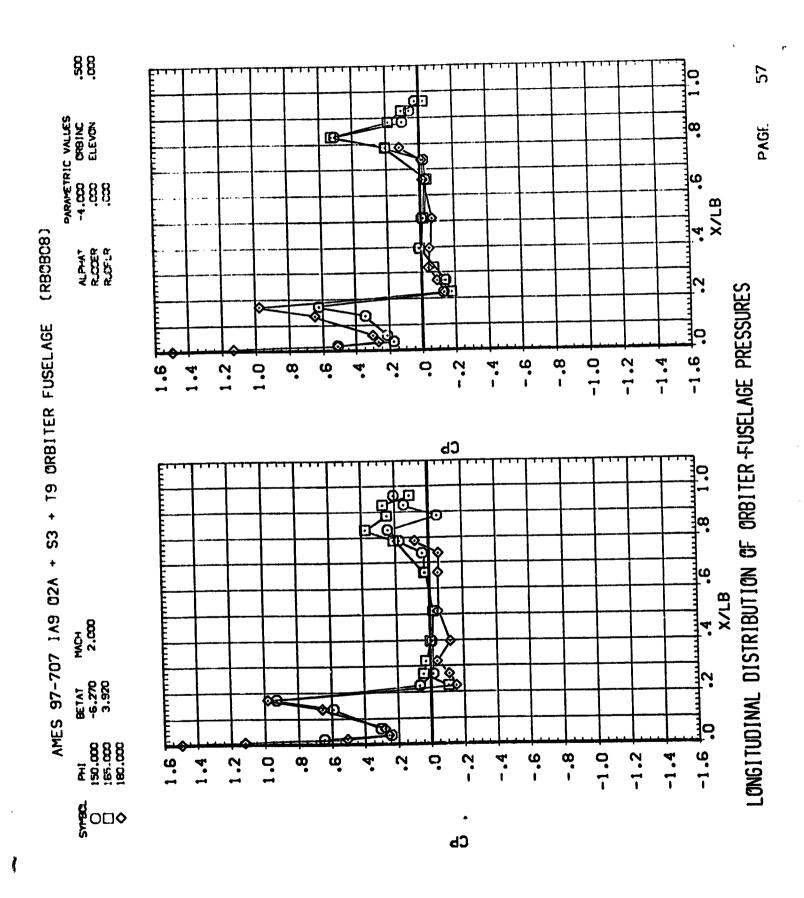


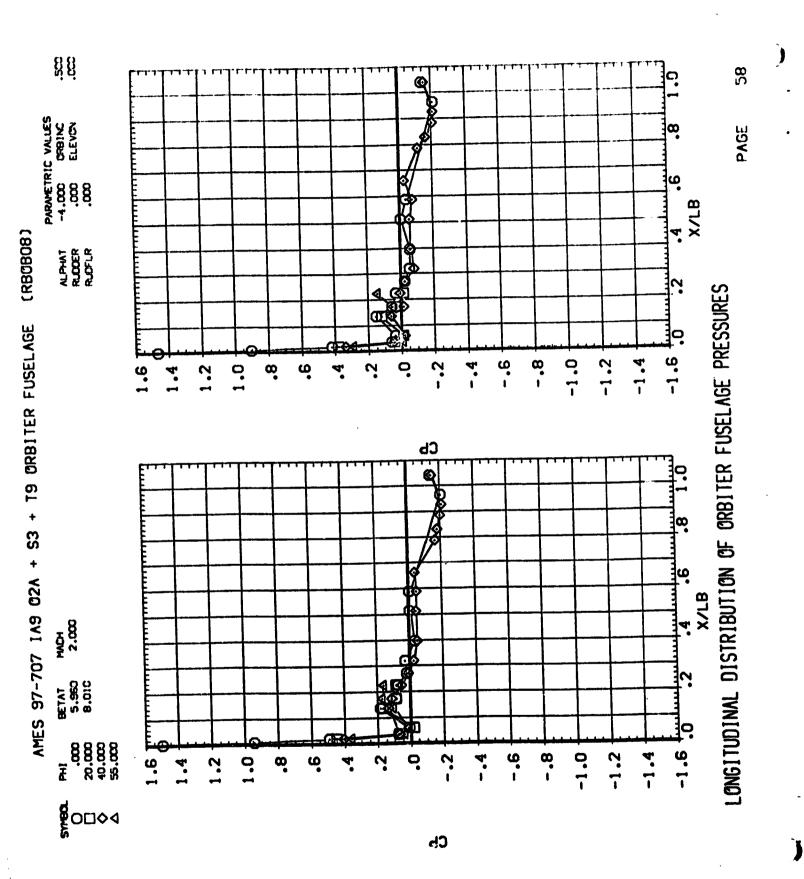
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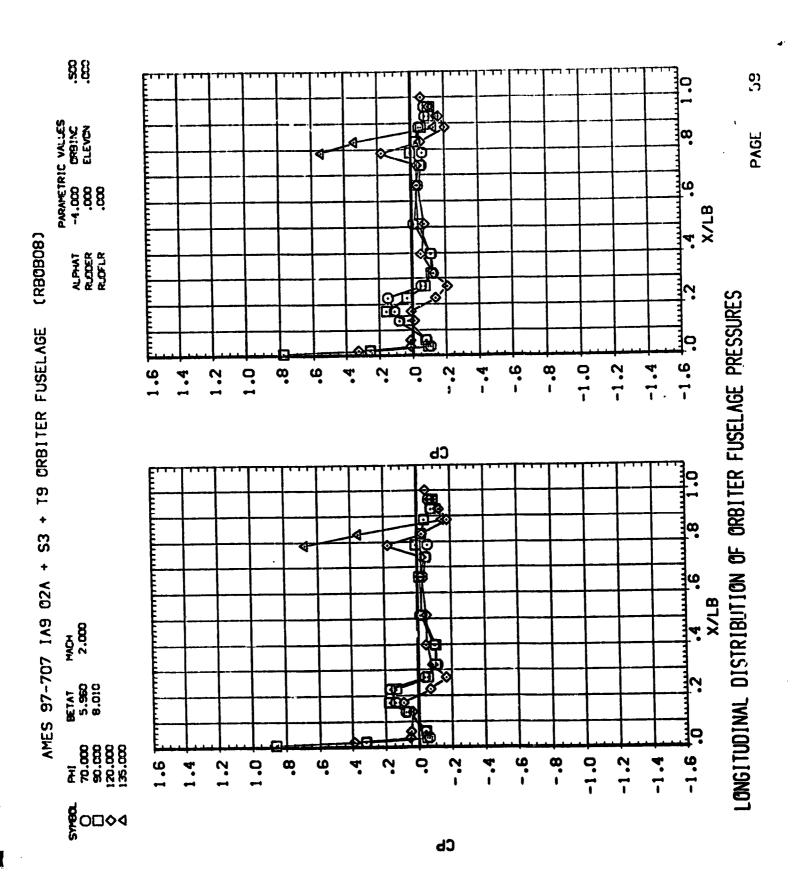




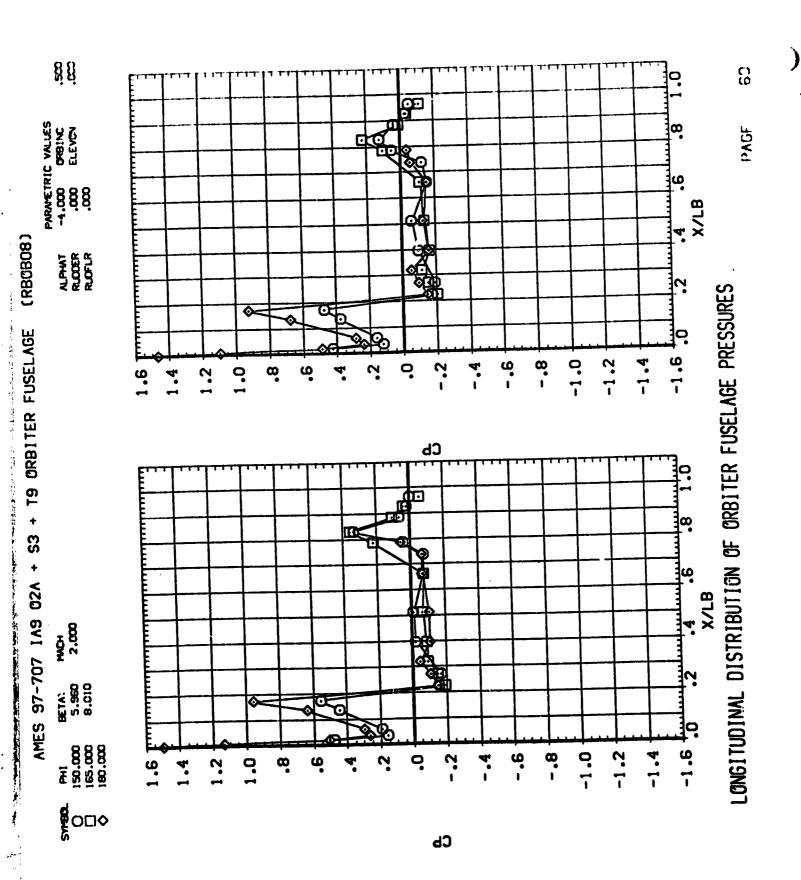




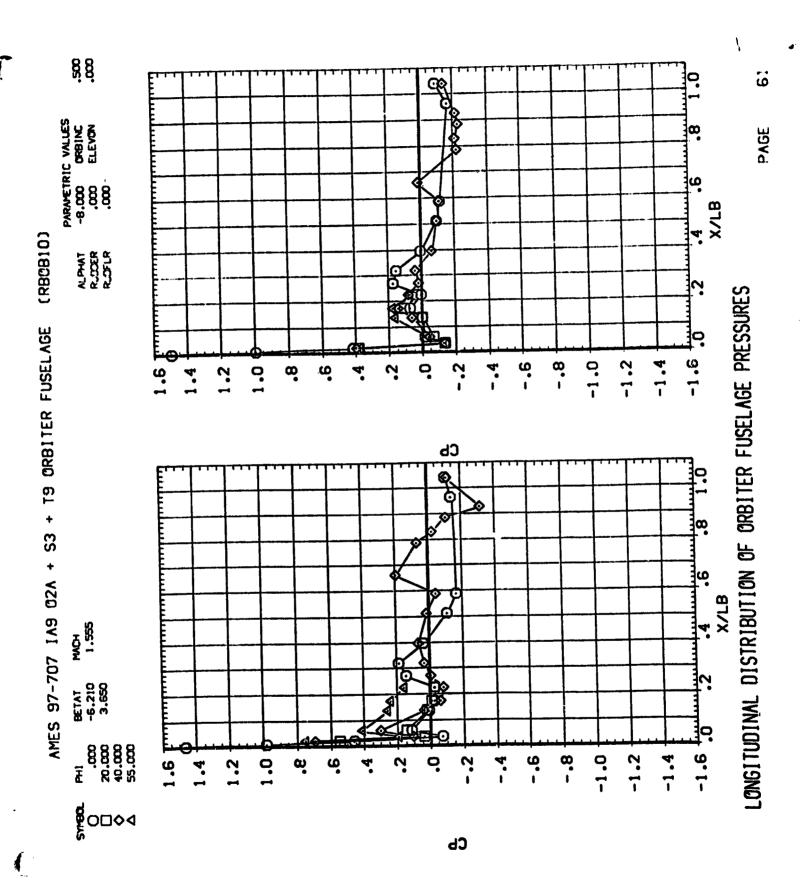


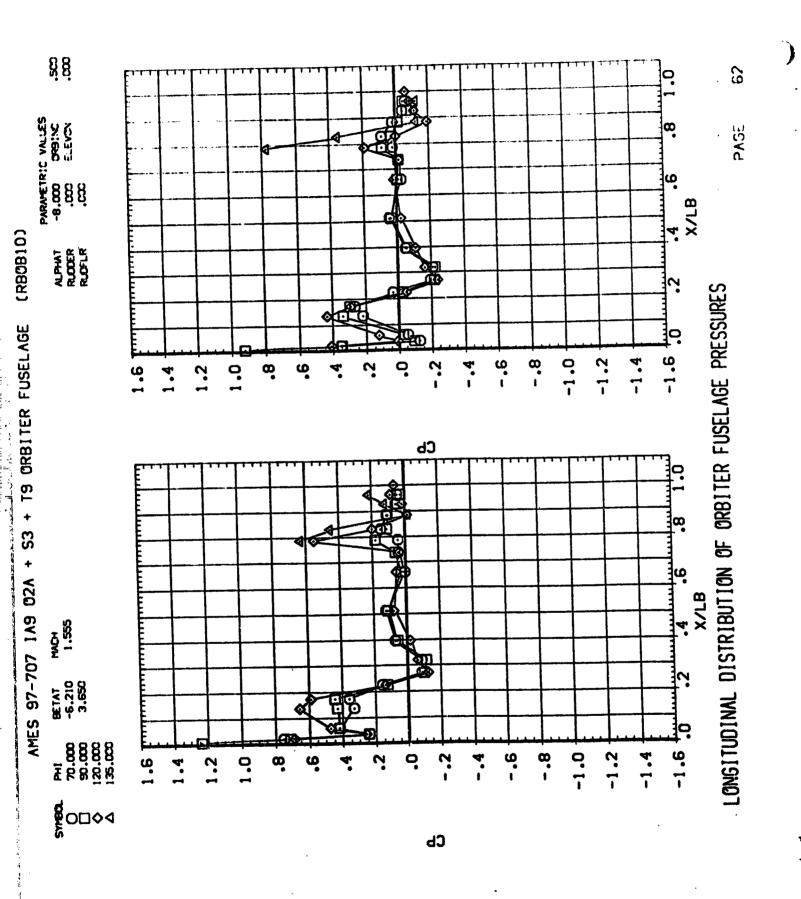


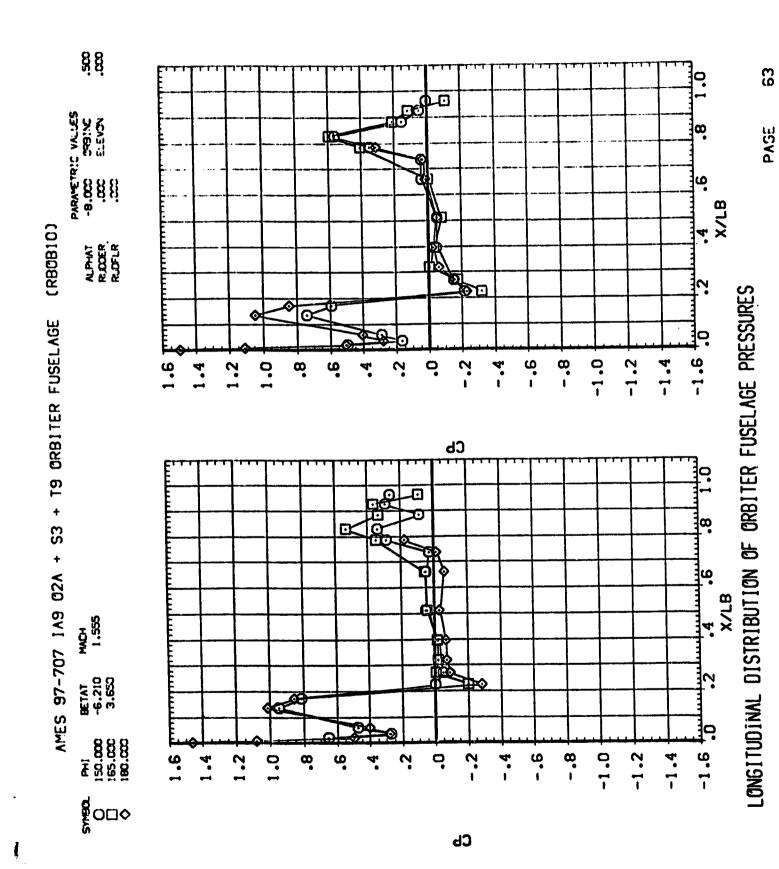
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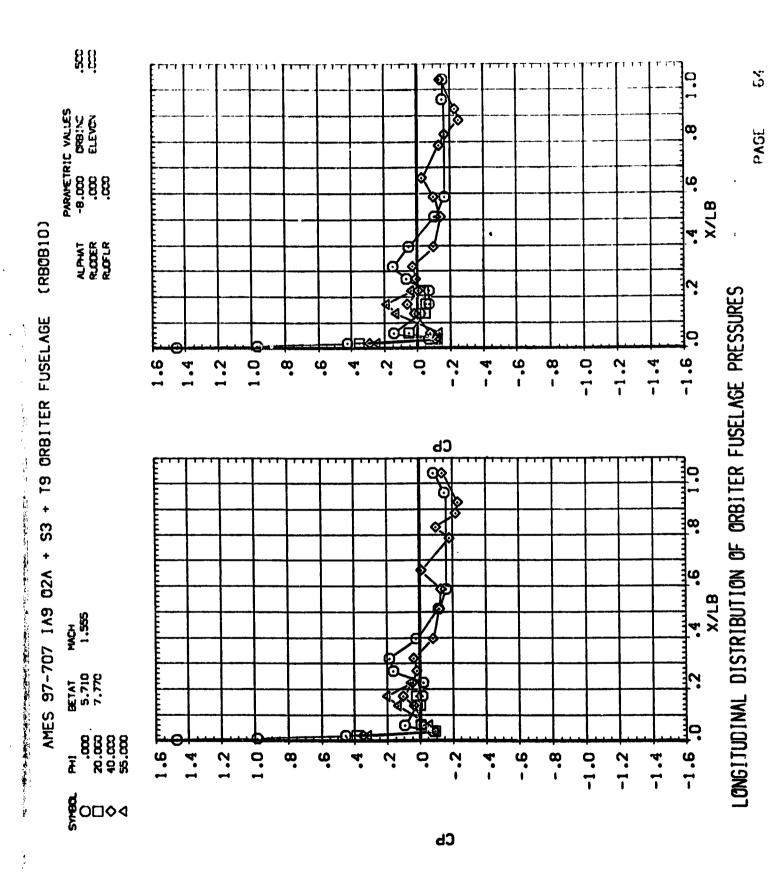
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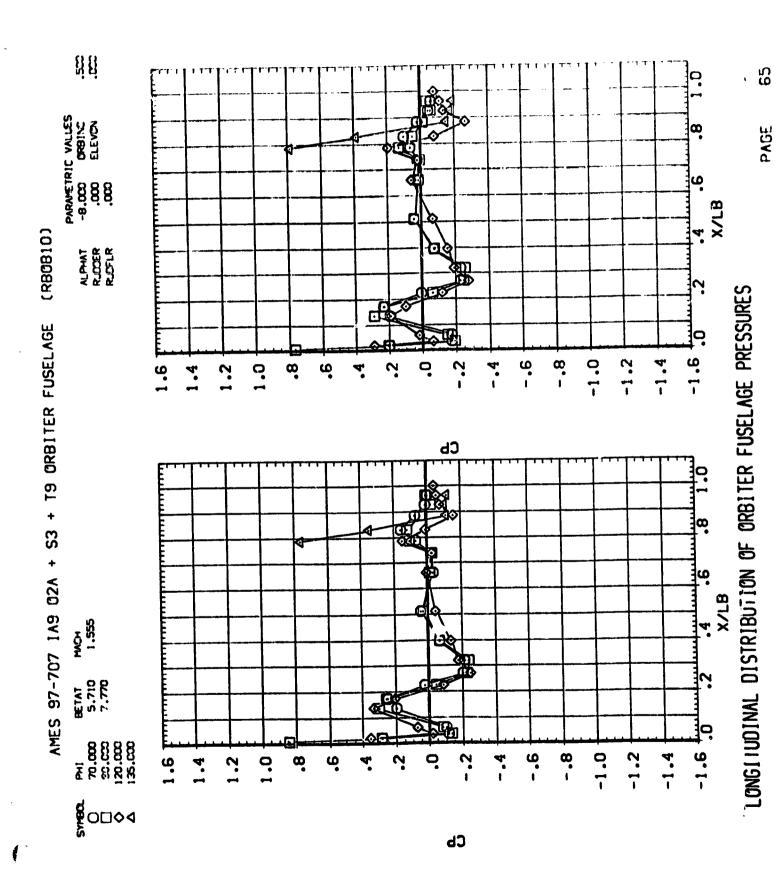




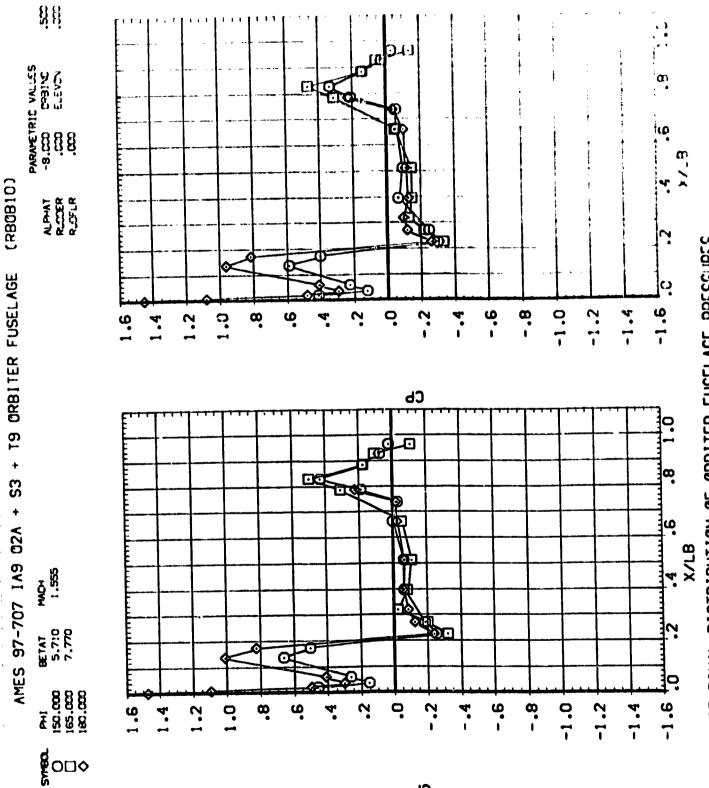


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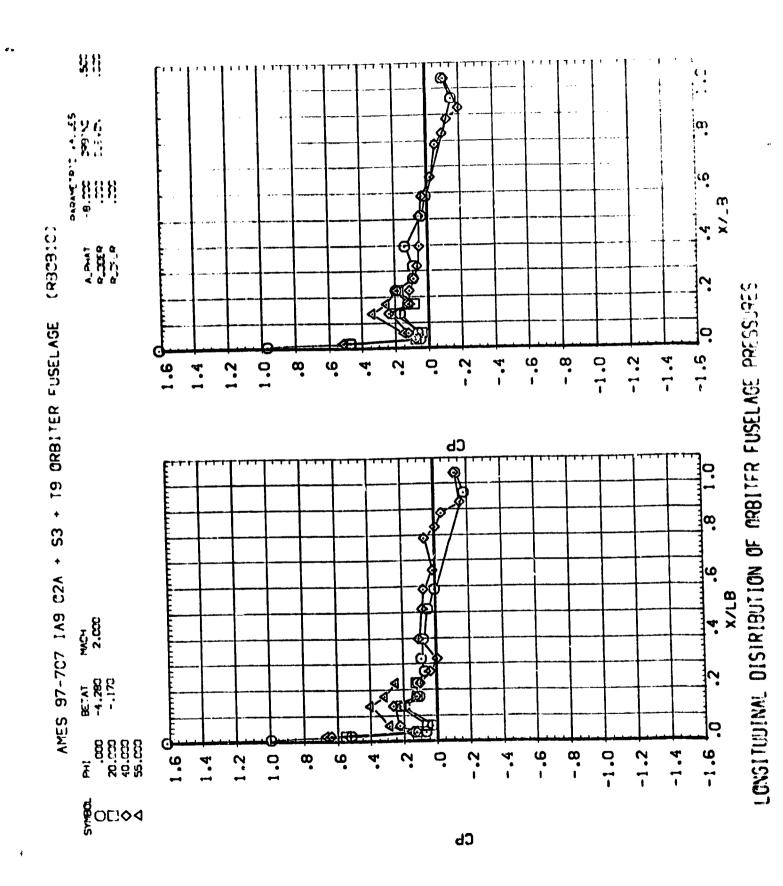


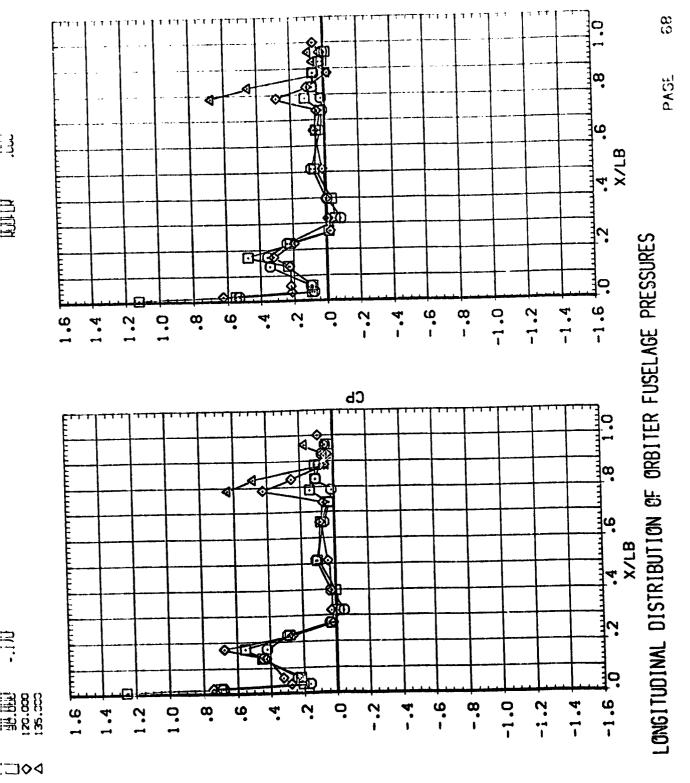
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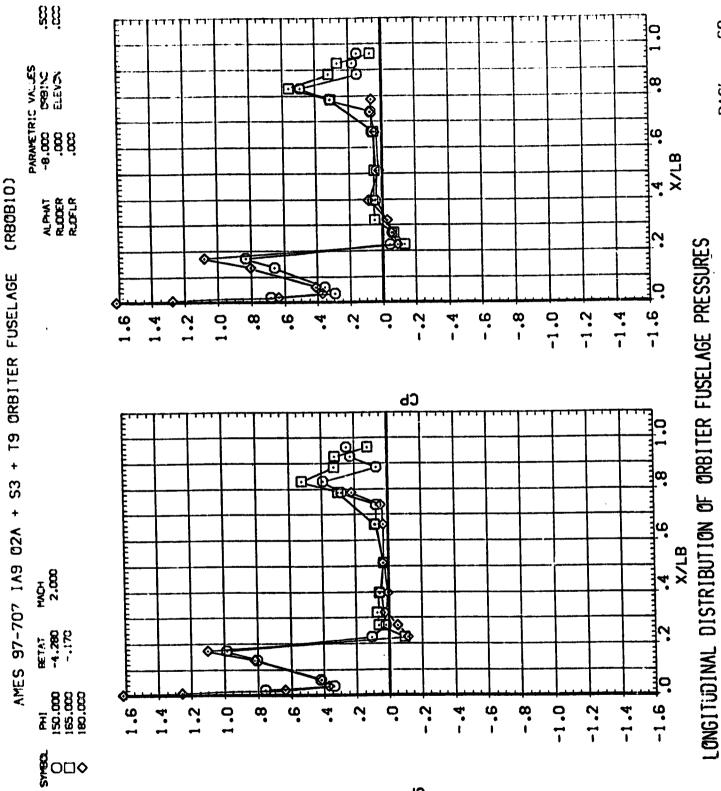


LONGITUDINAL DISTRIBUTION OF ORBITER FUSELAGE PRESSURES

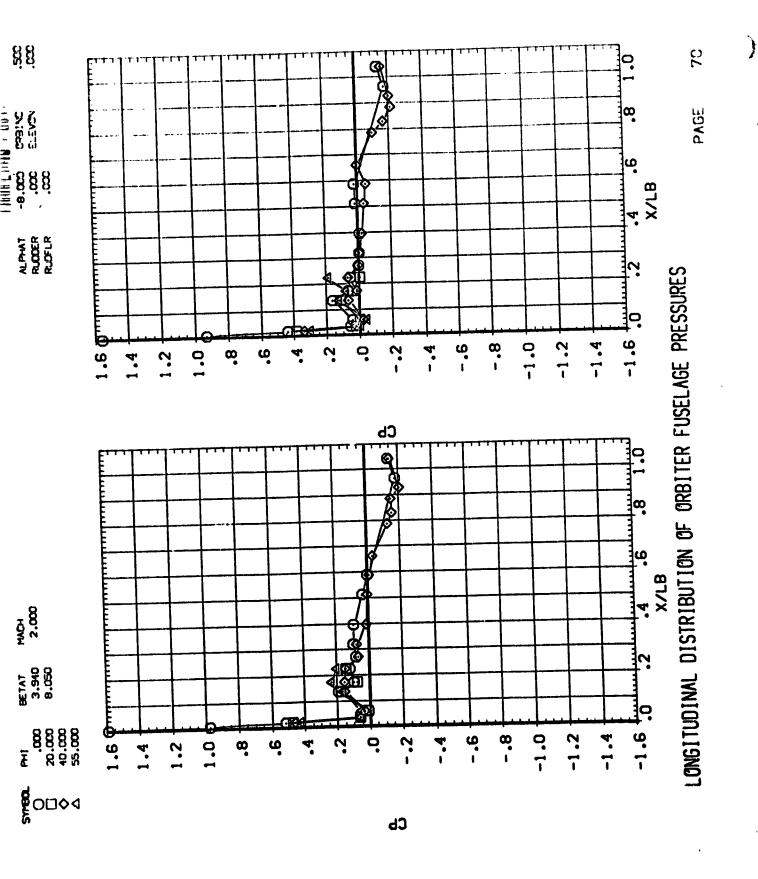
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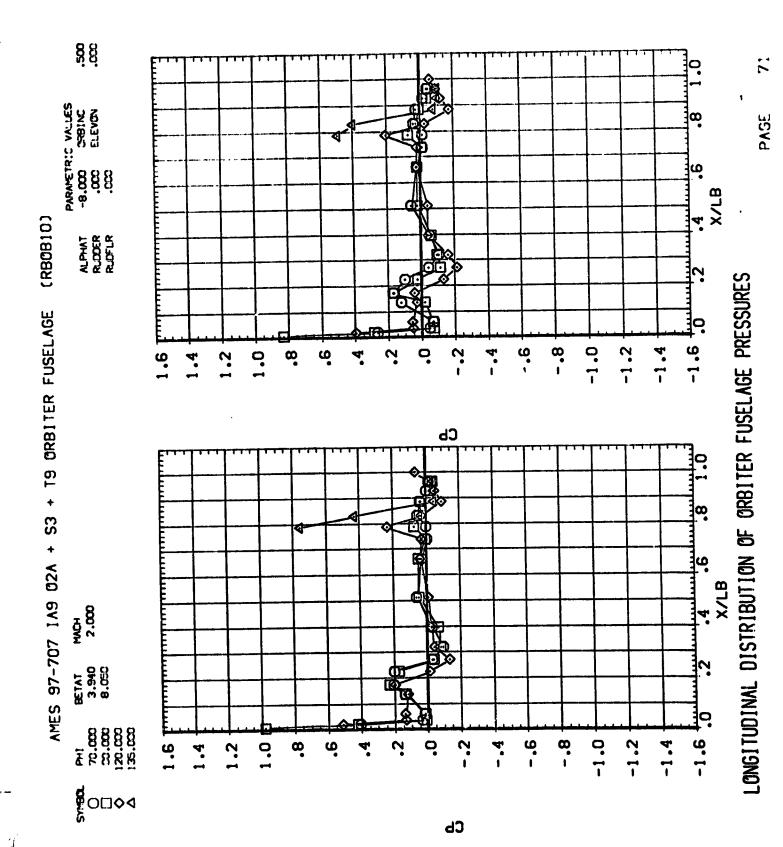


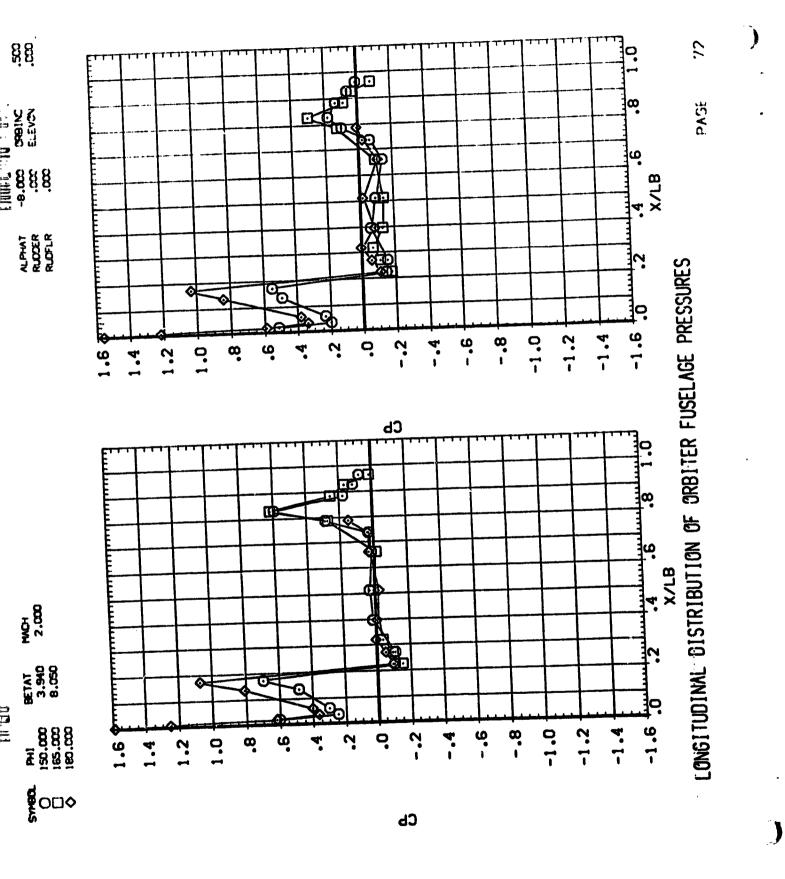


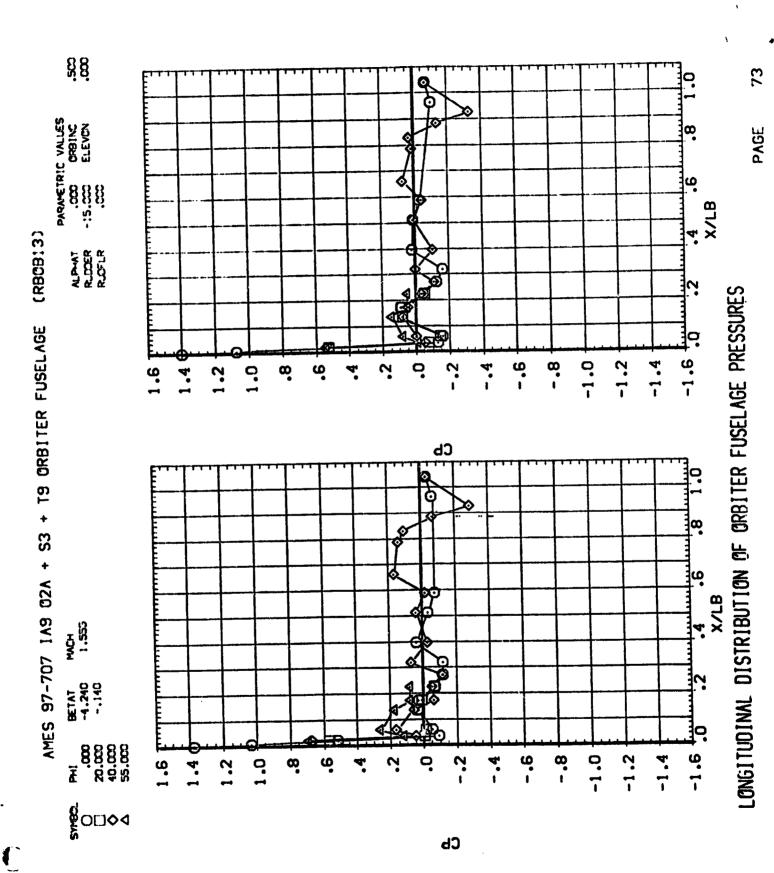


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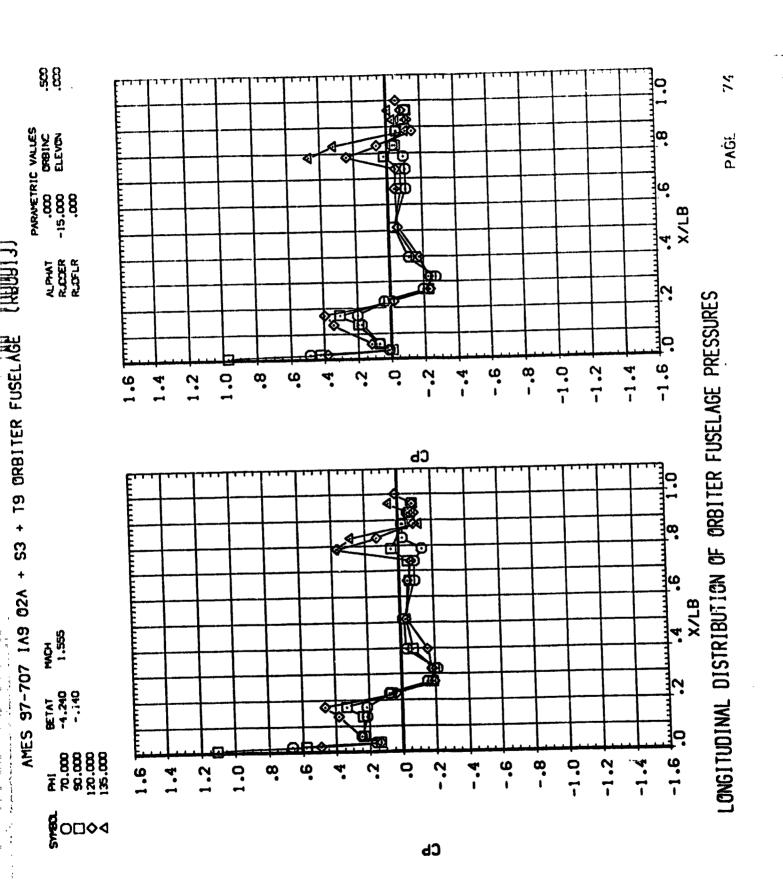


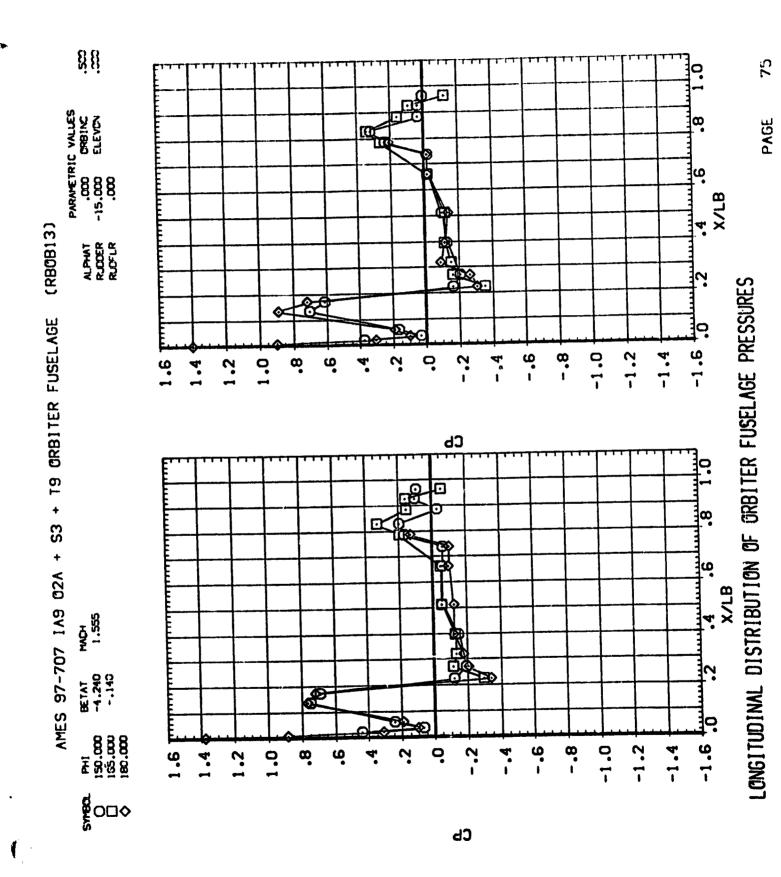






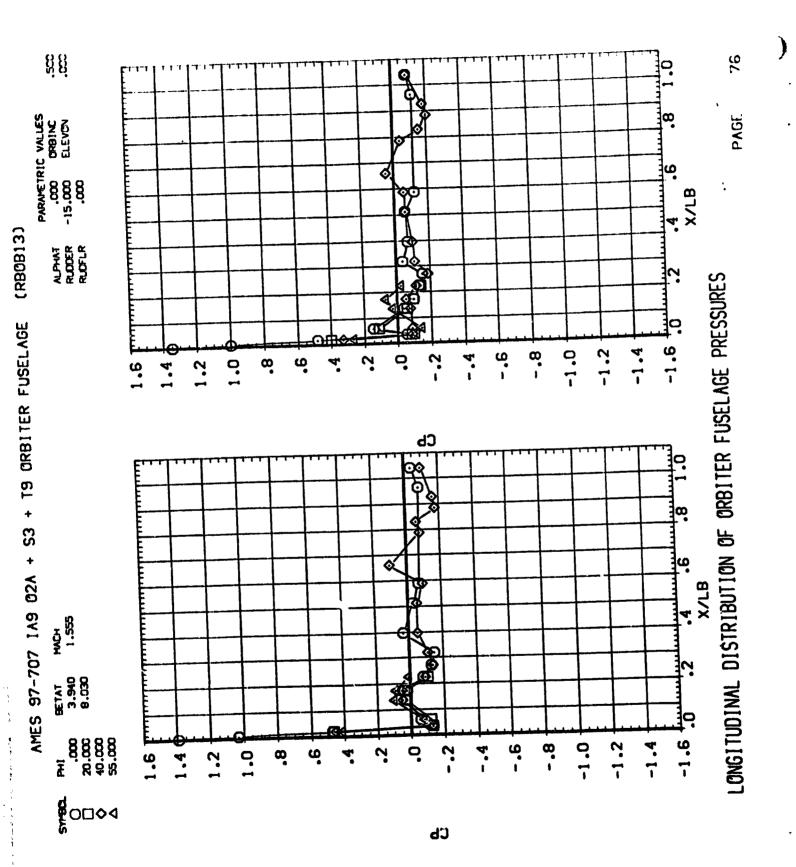
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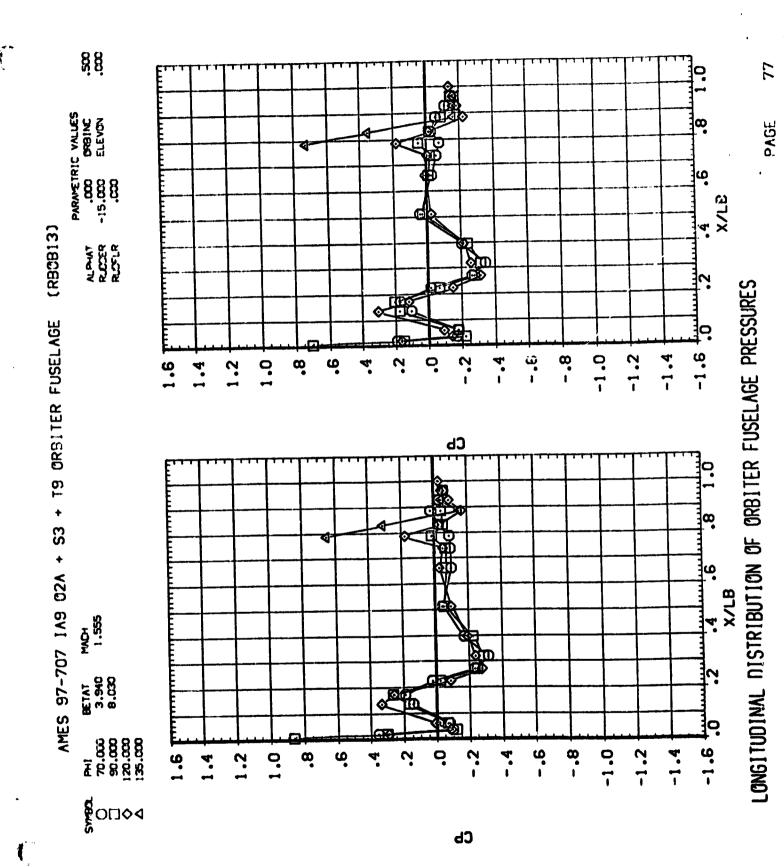


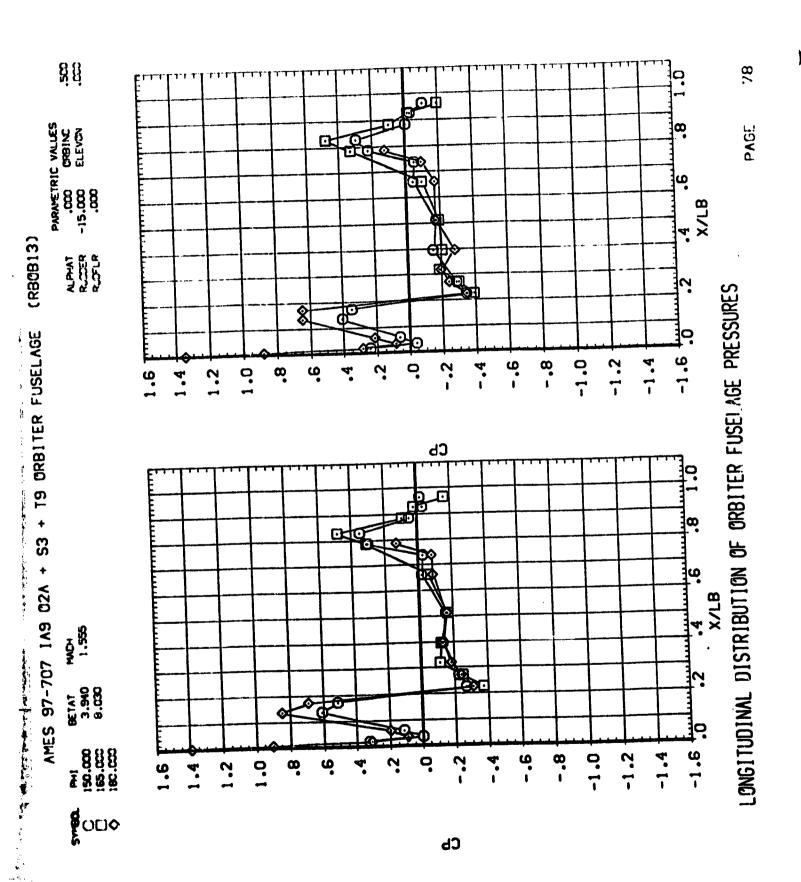


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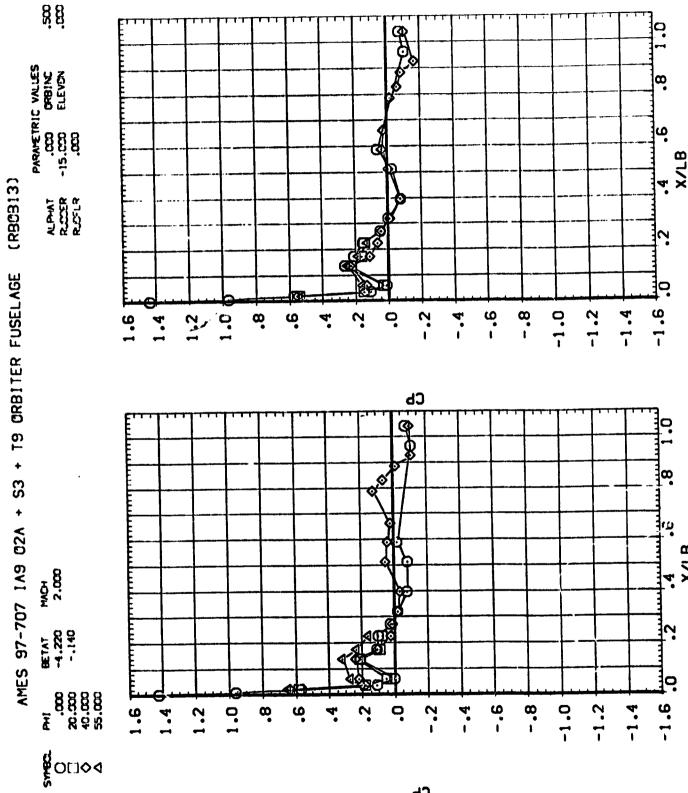
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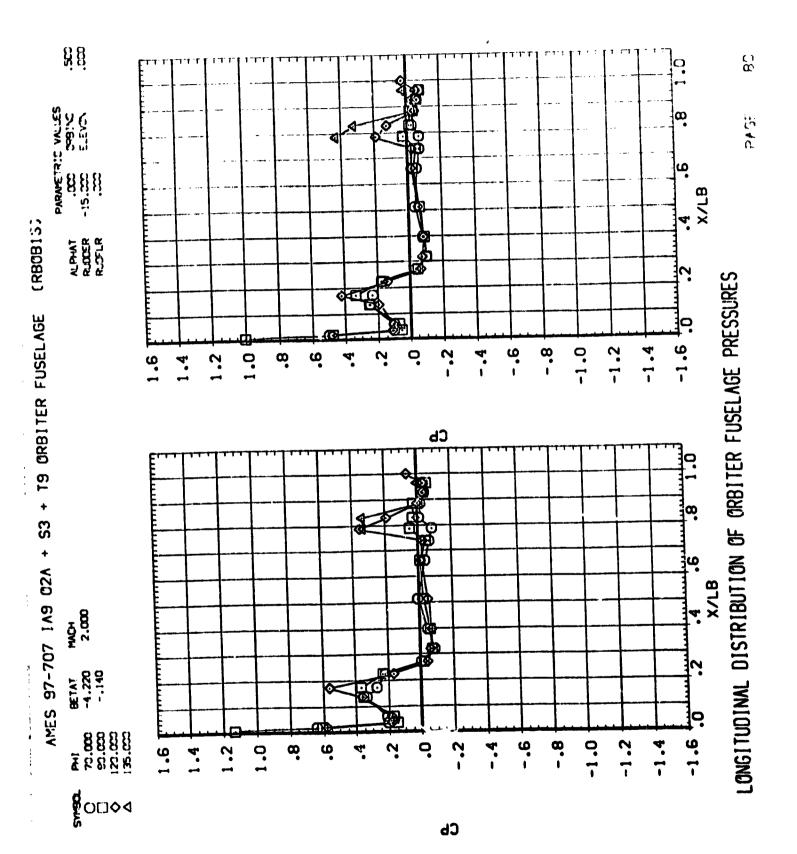




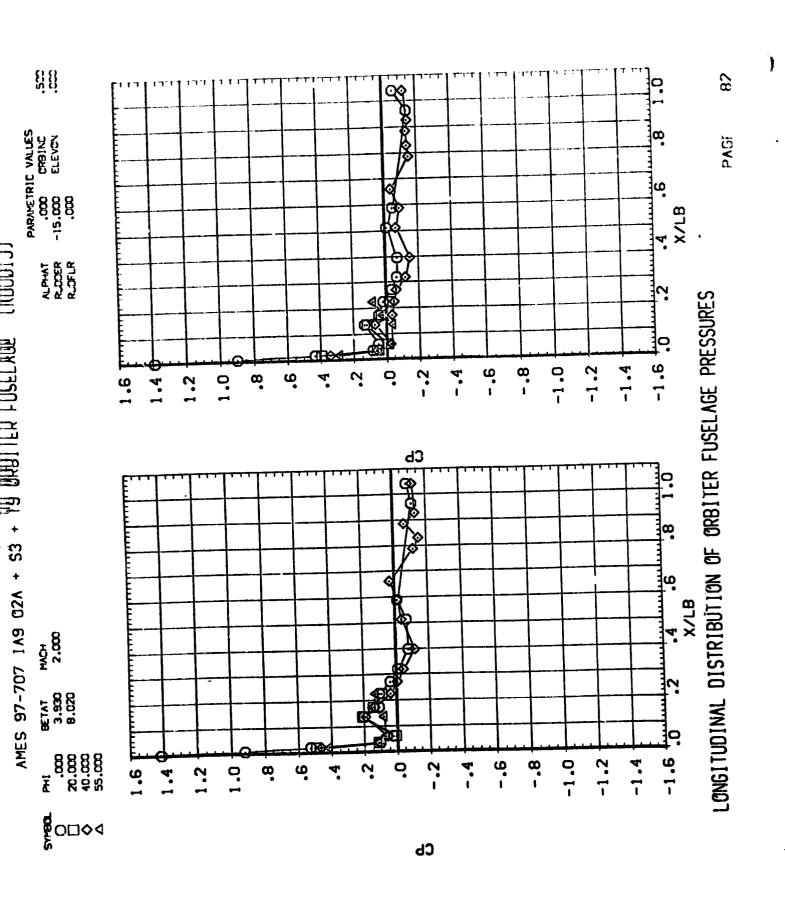
LONGITUDINAL DISTRIBUTION OF ORBITER FUSELAGE PRESSURES

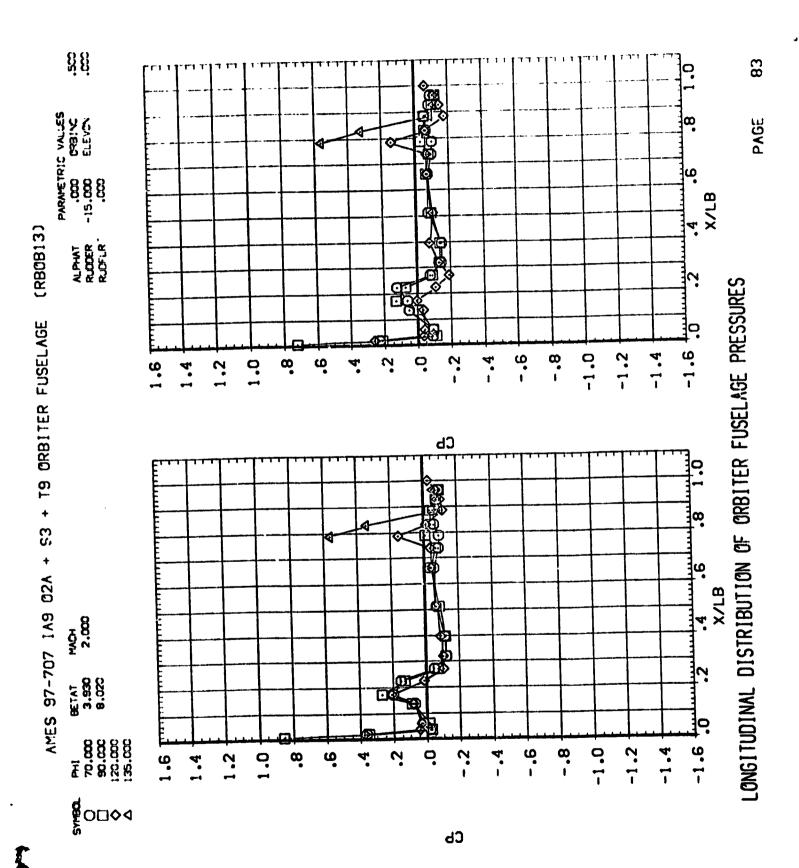


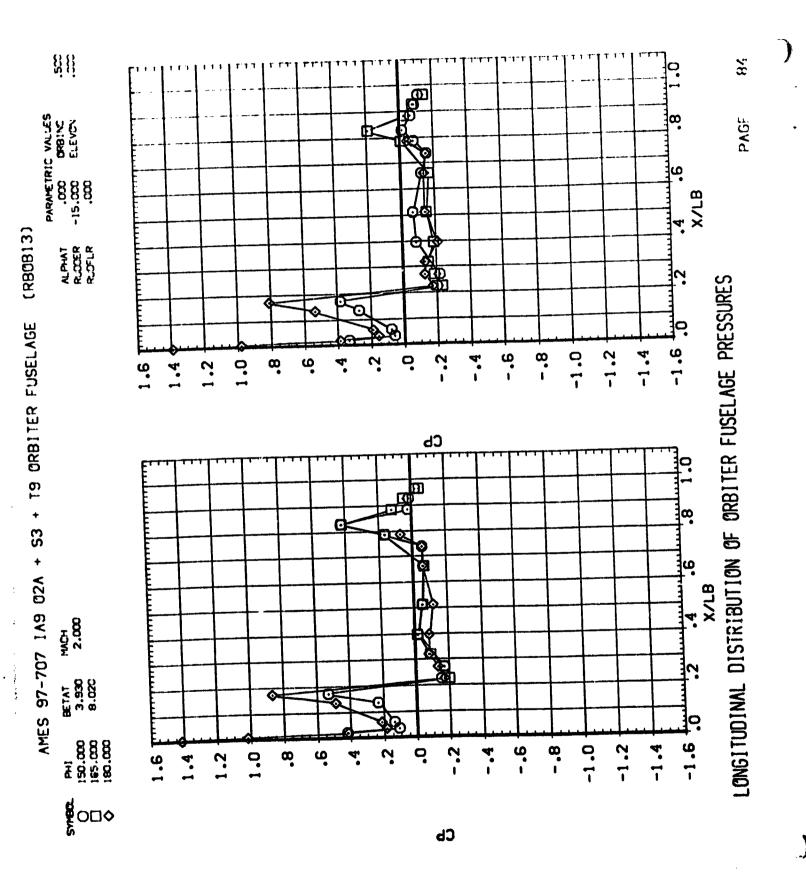
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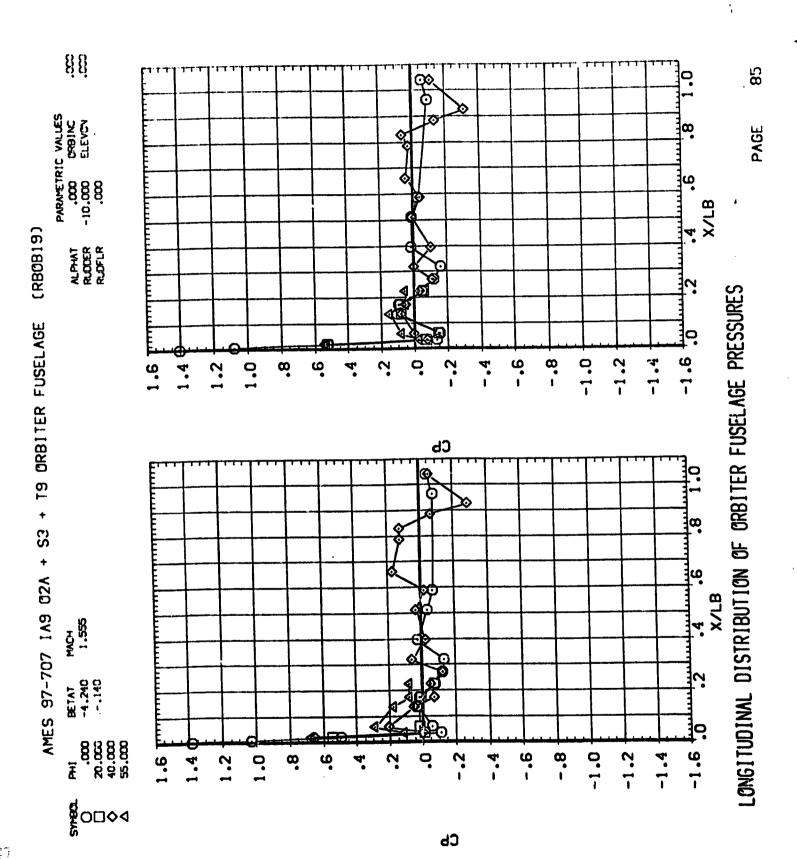


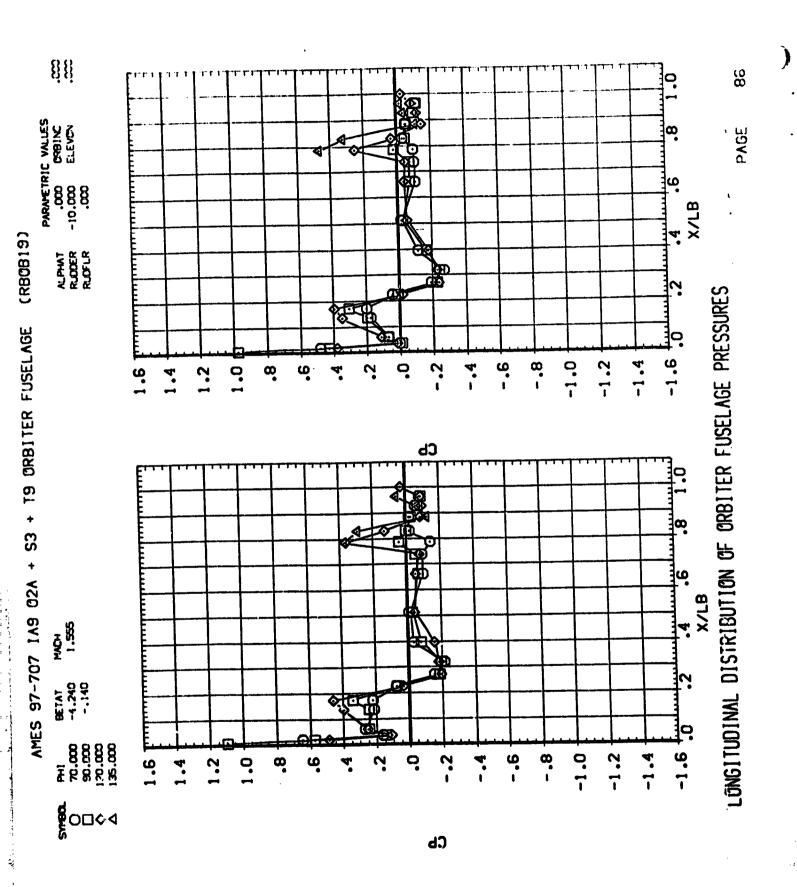
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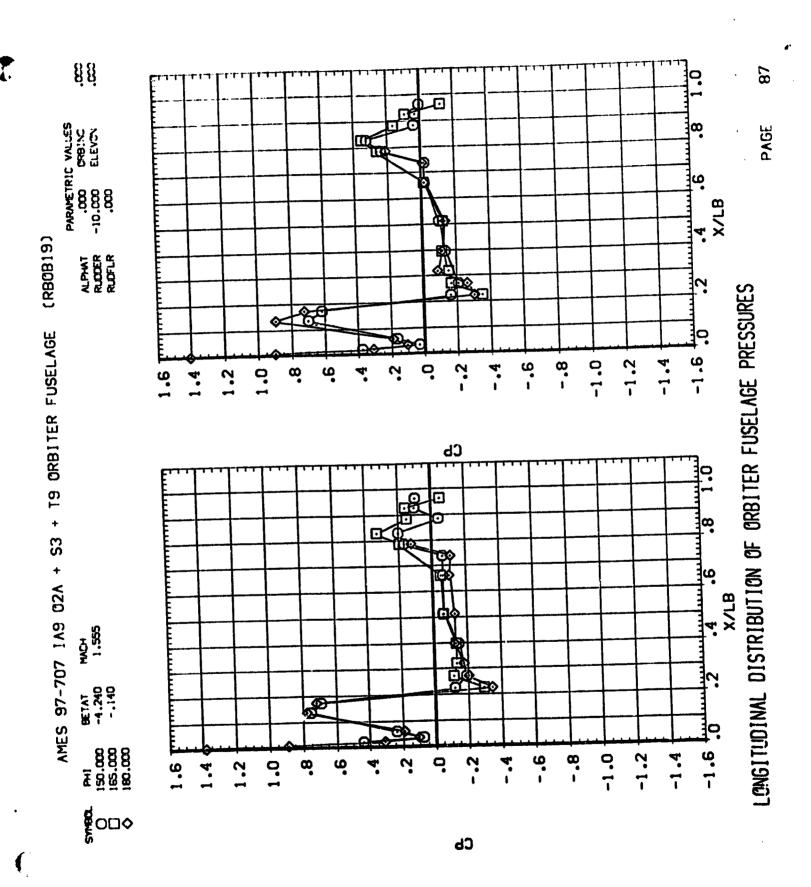




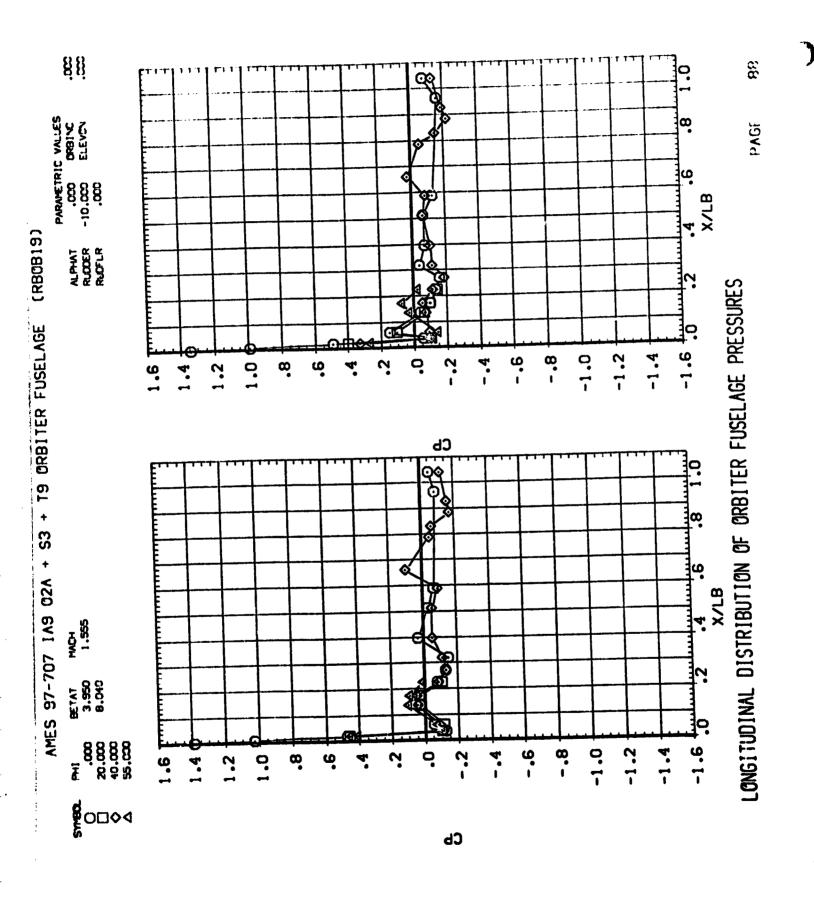


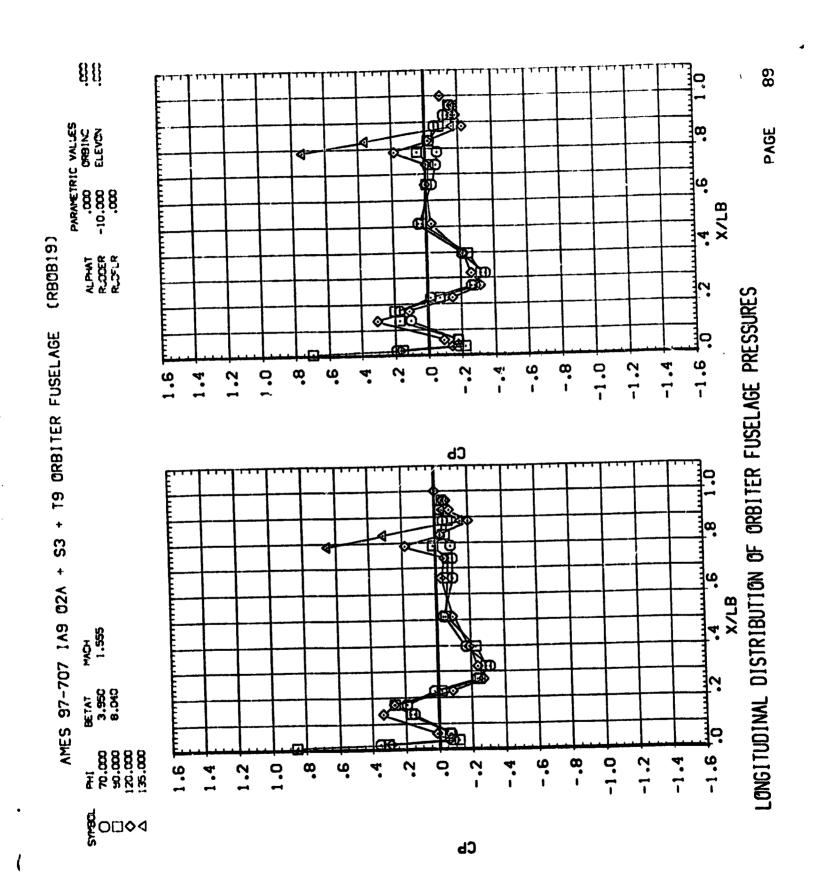


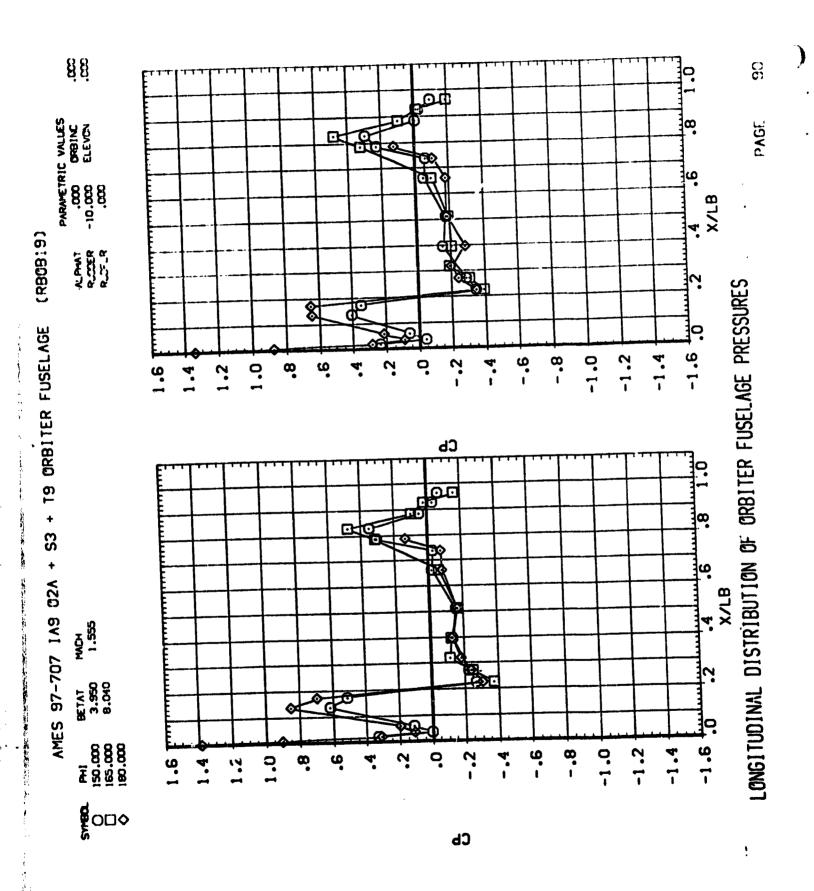


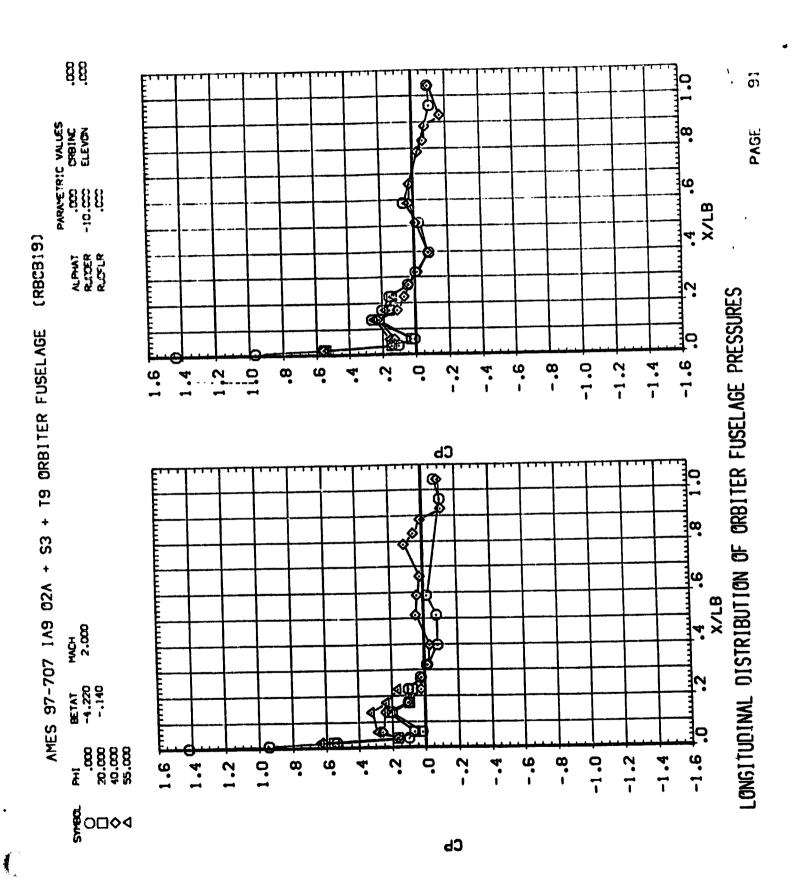


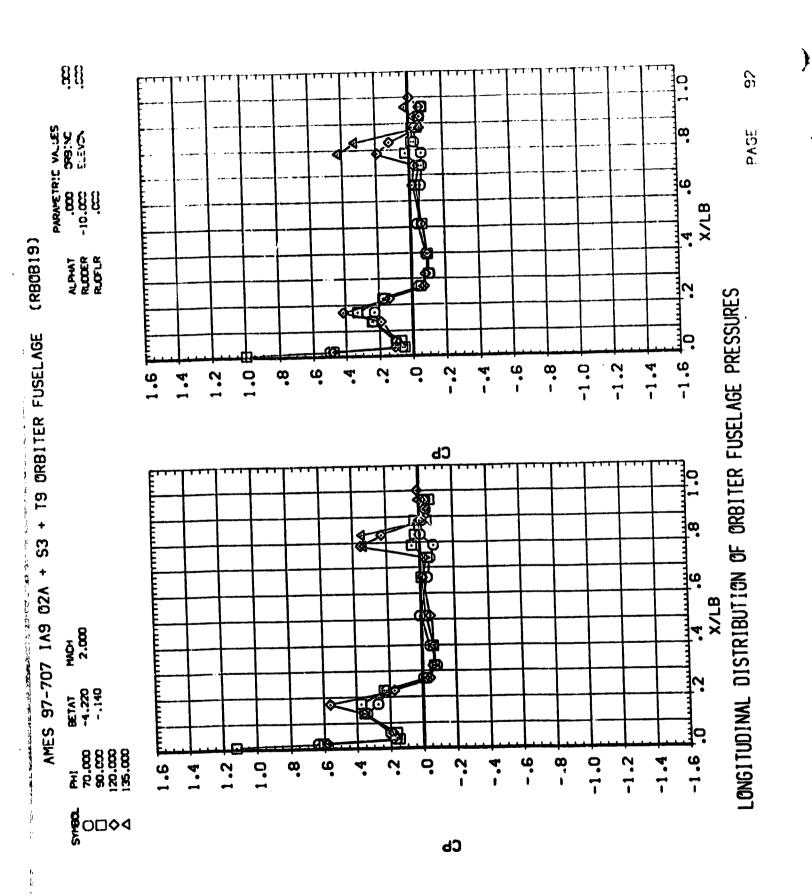
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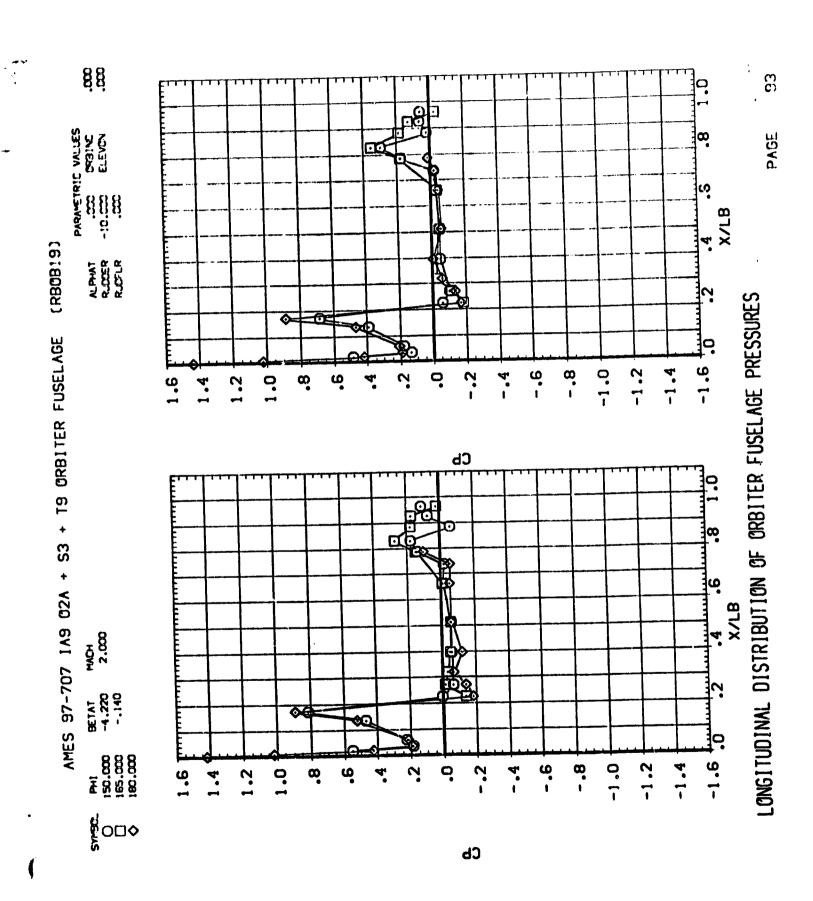


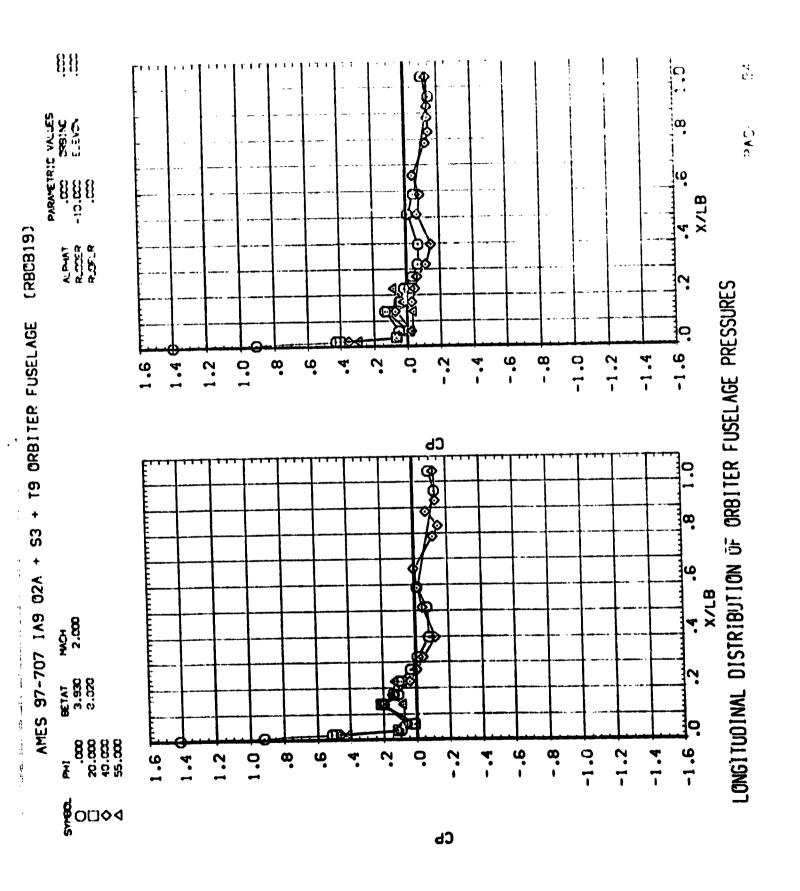




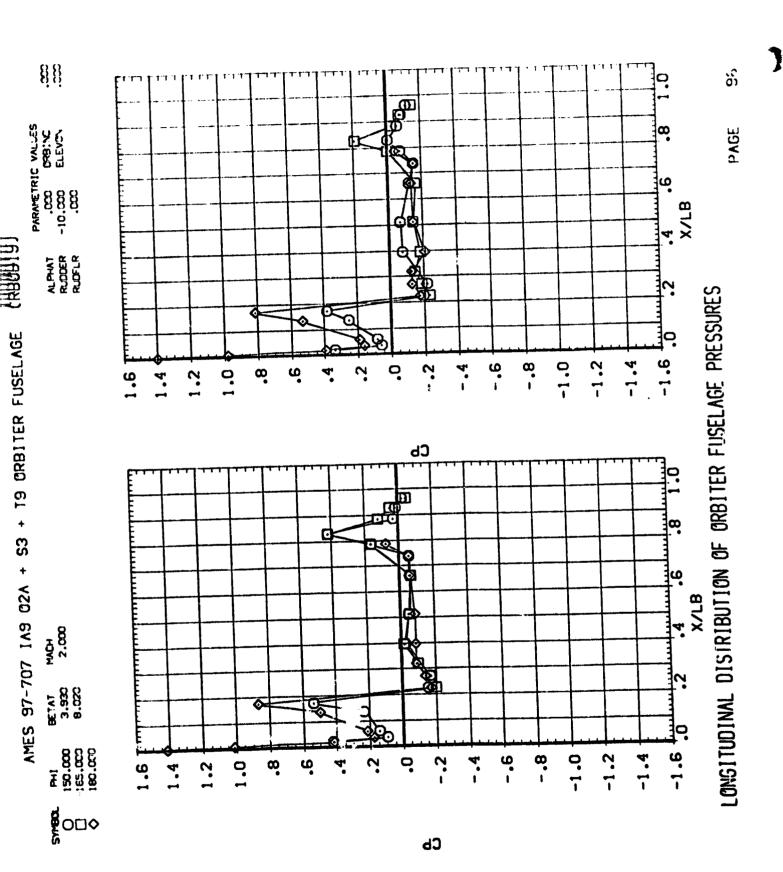


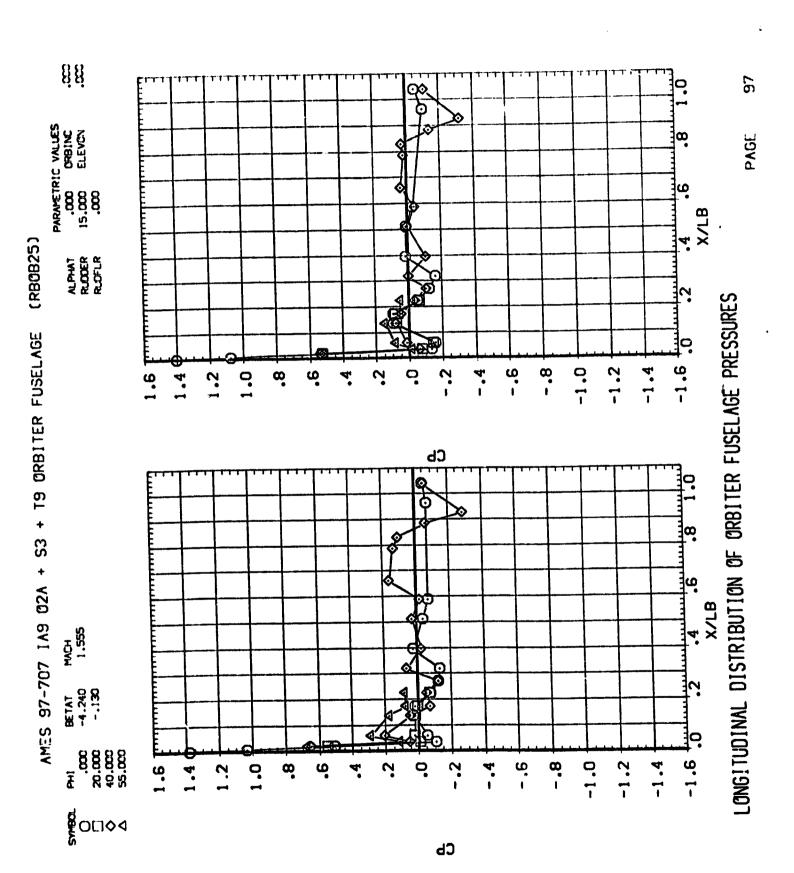


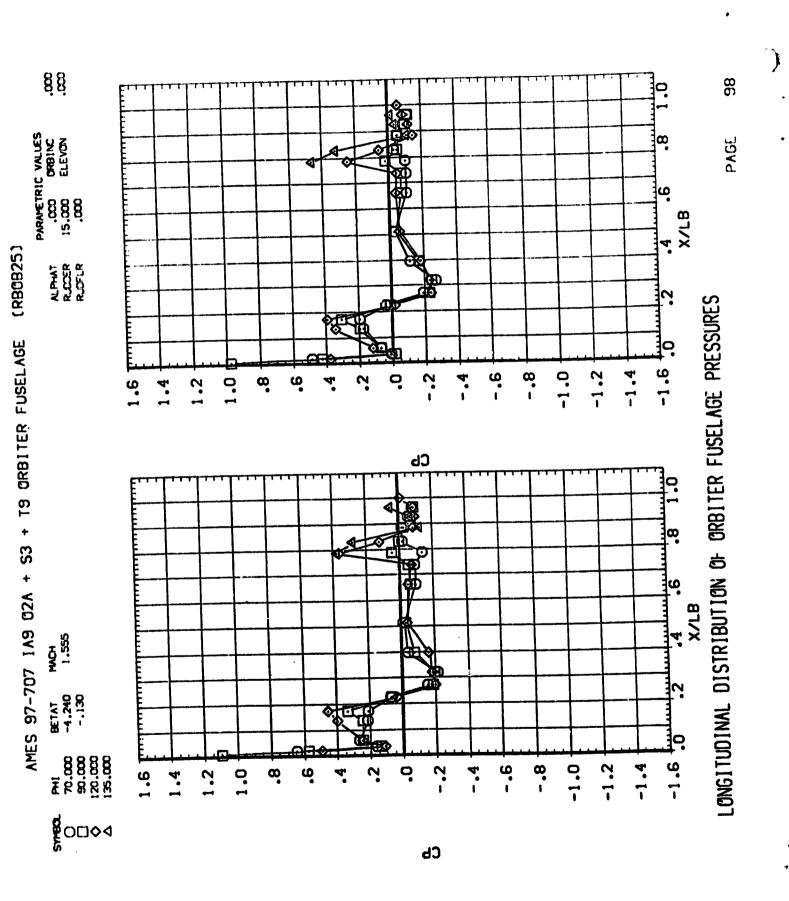


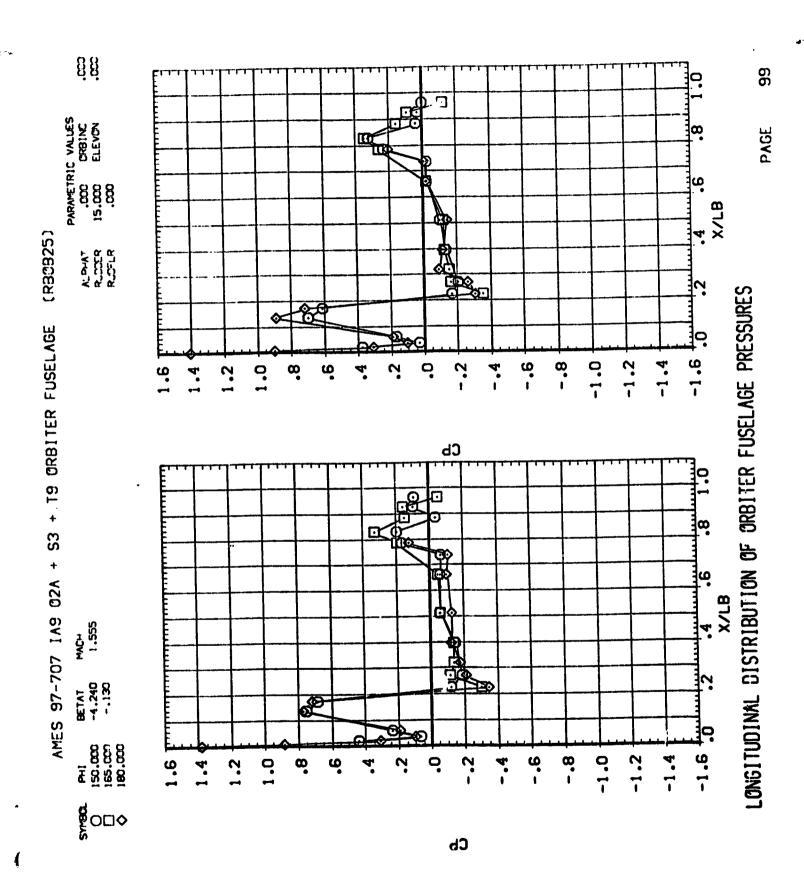


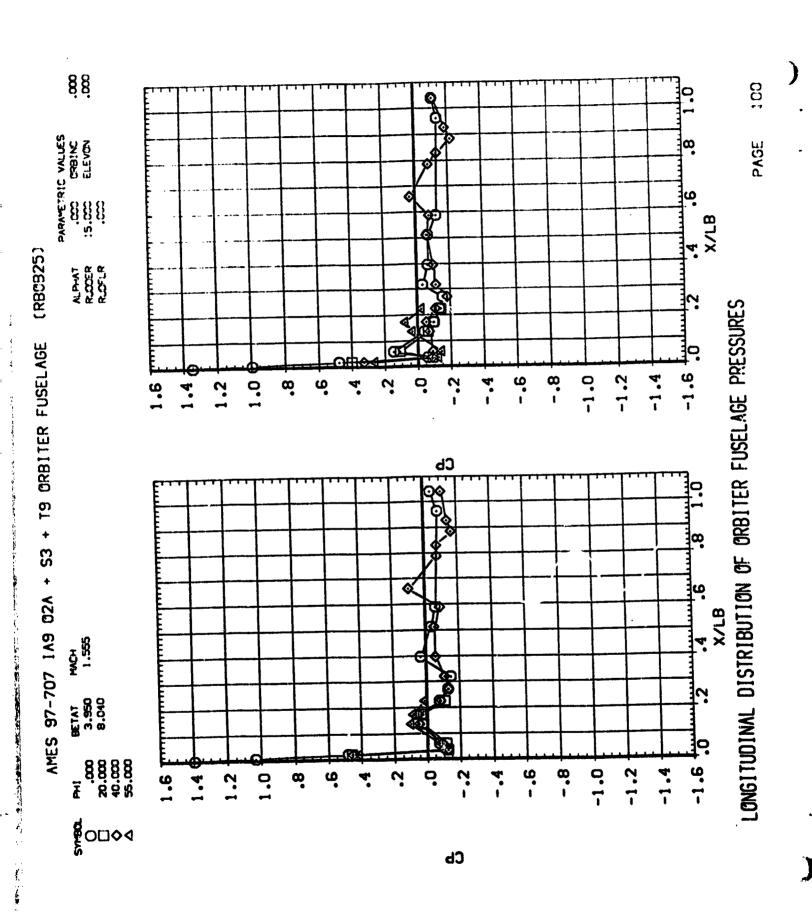
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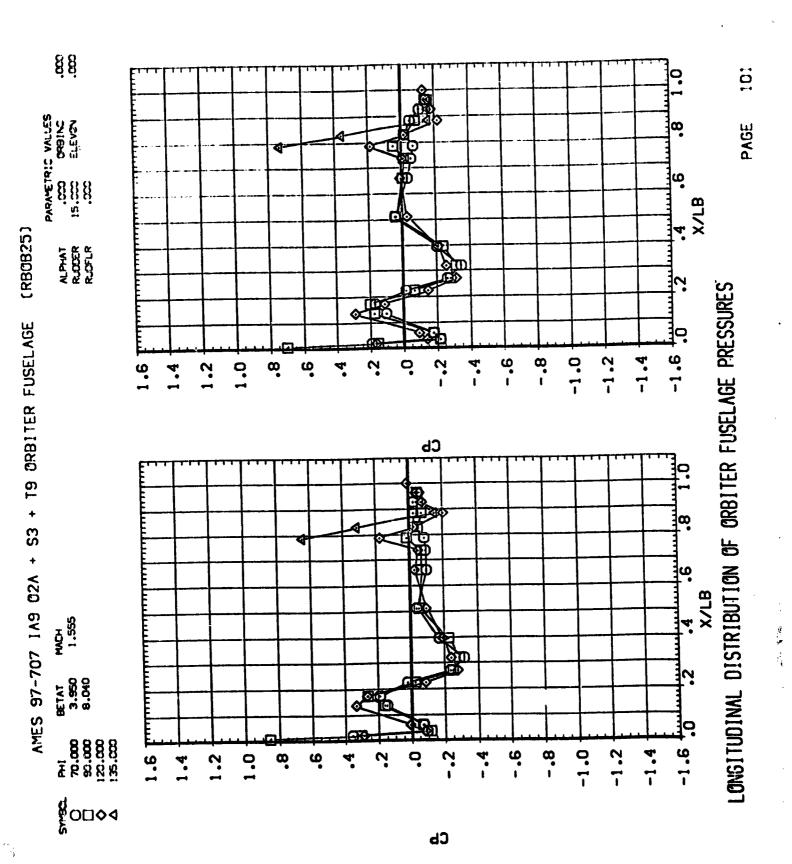


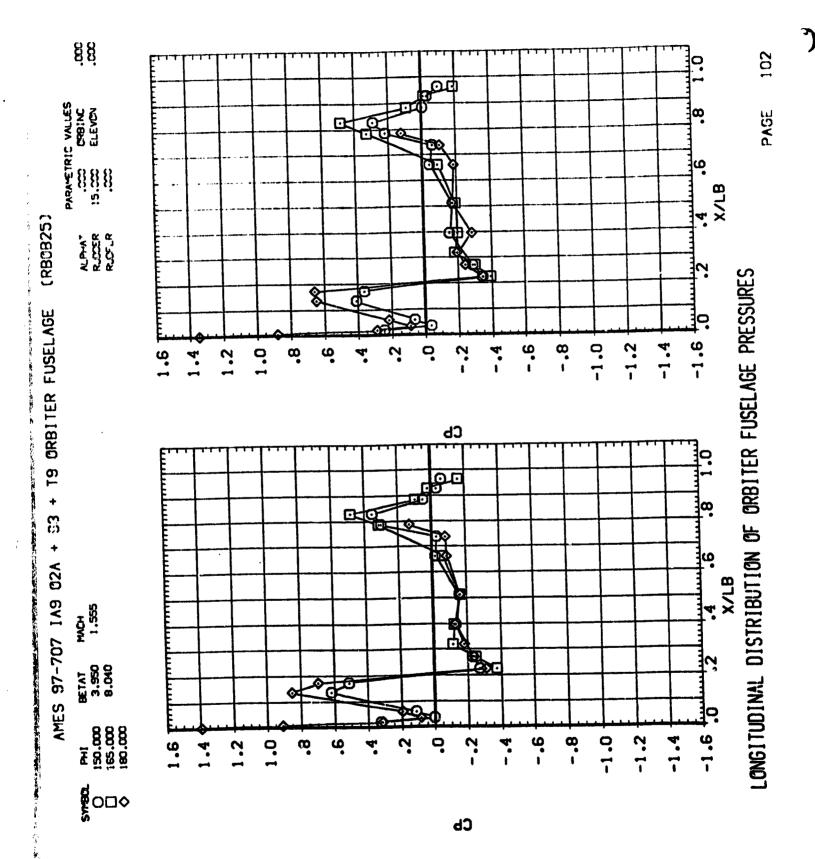


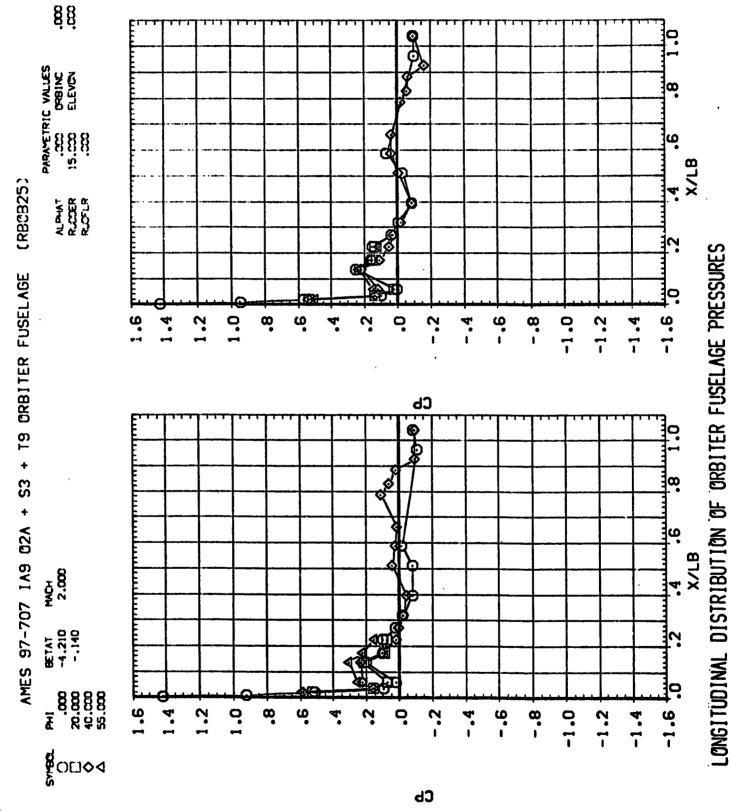






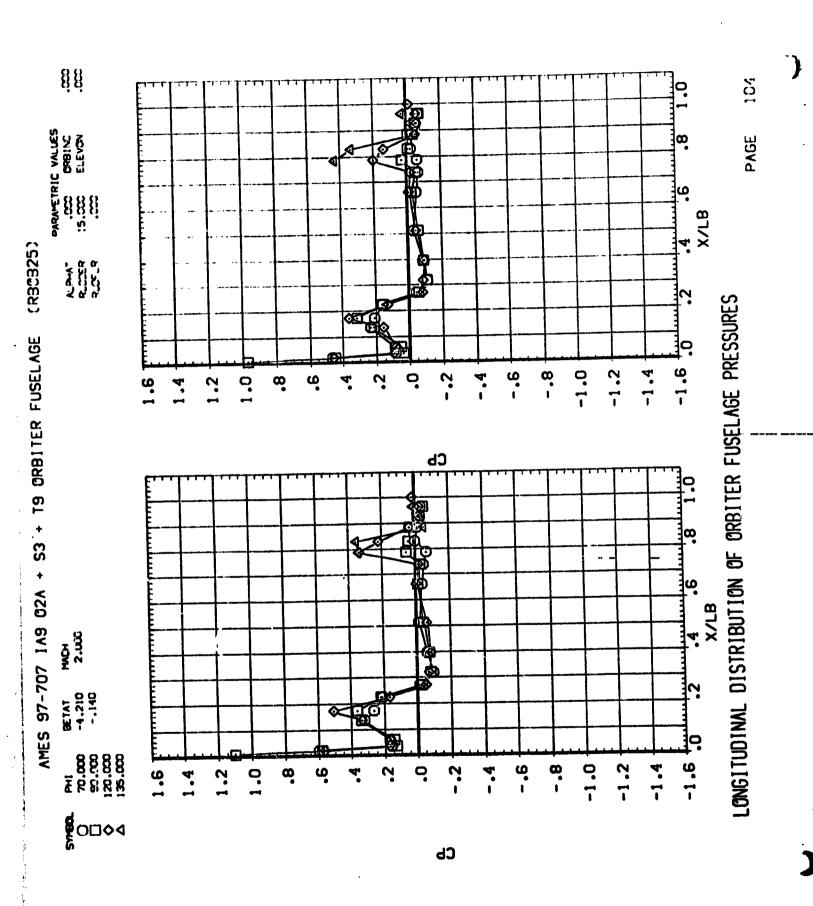


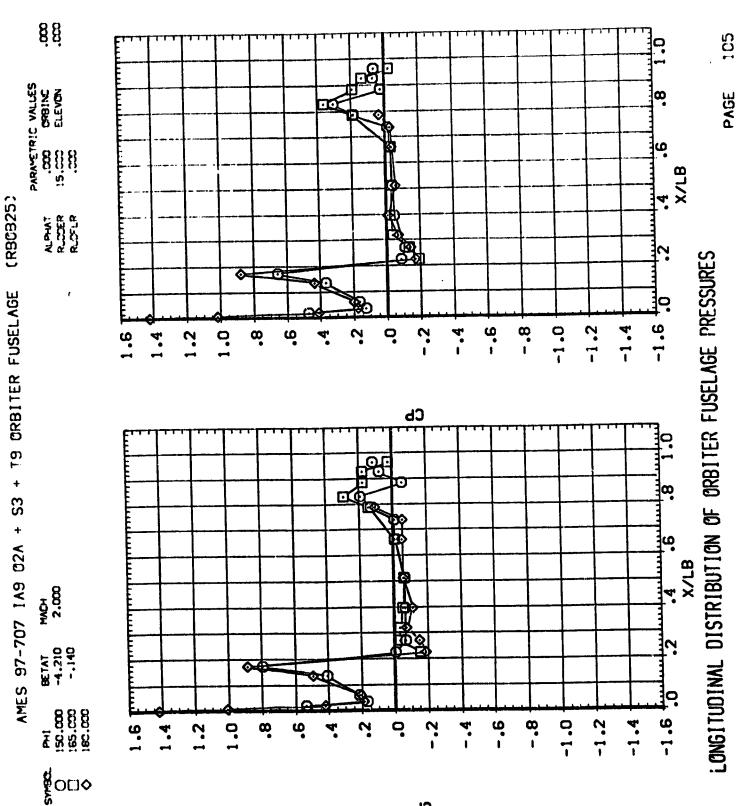




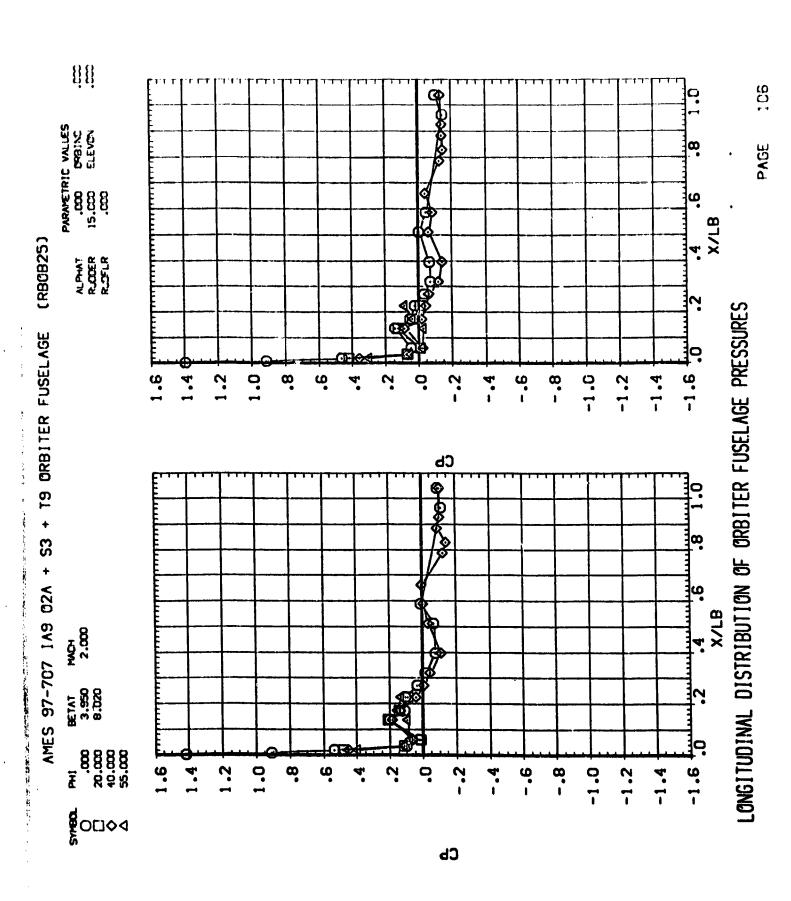
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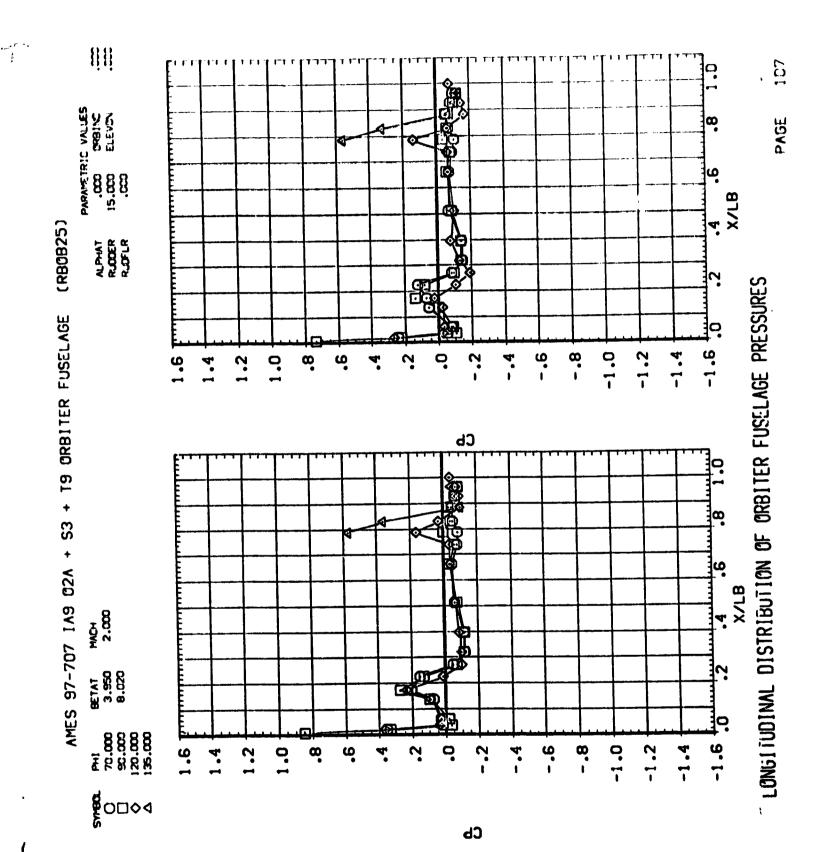
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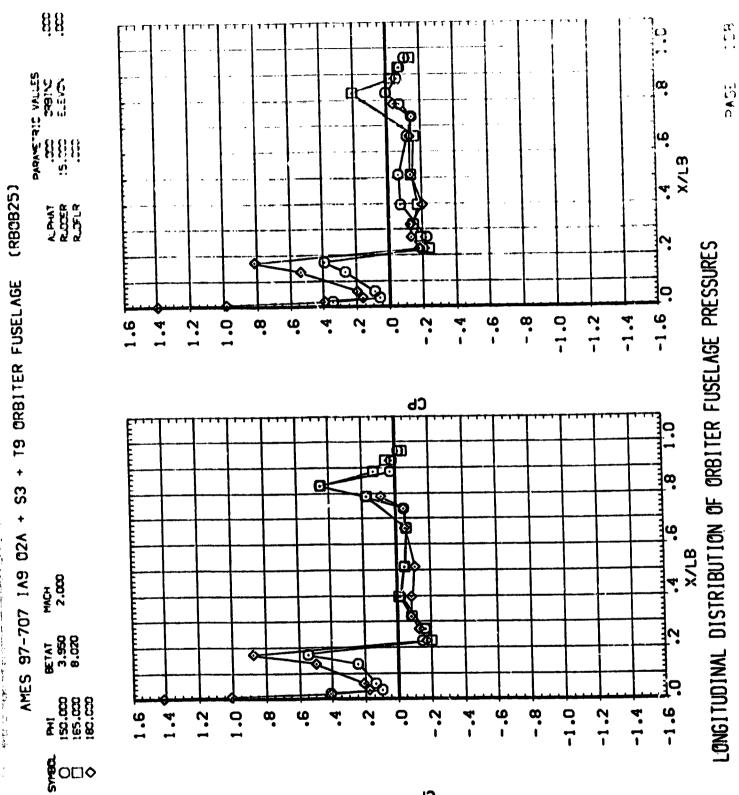




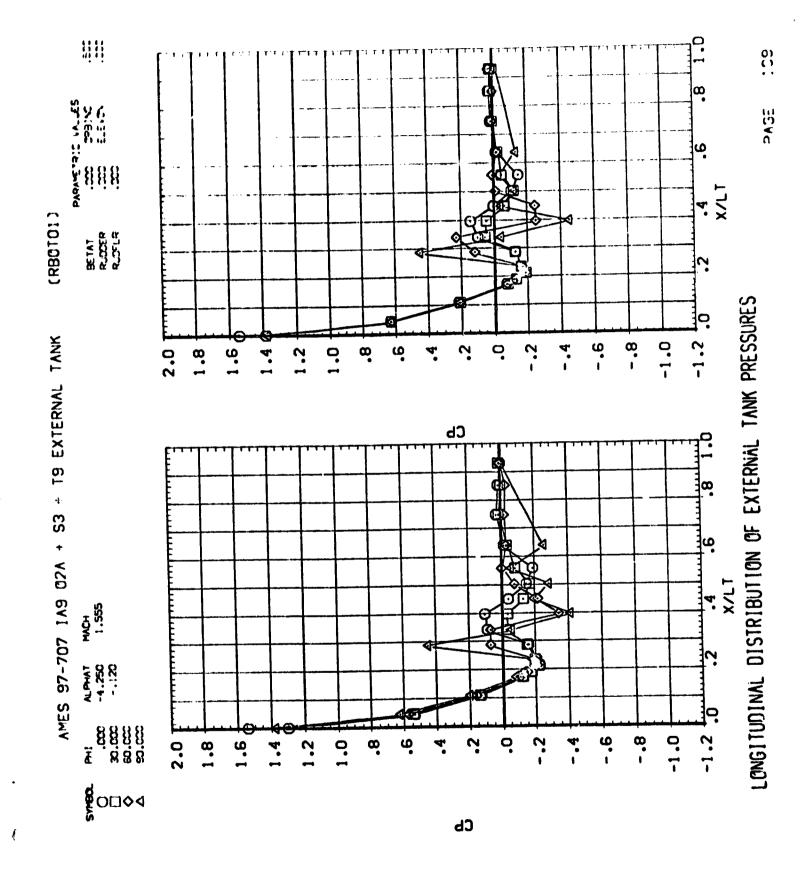
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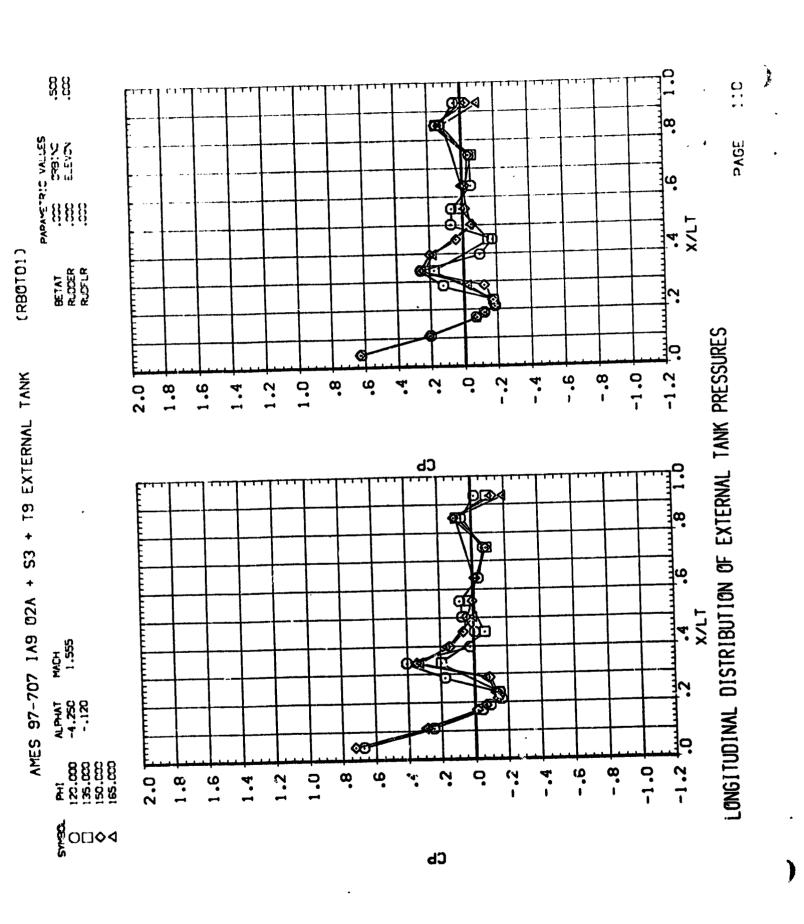


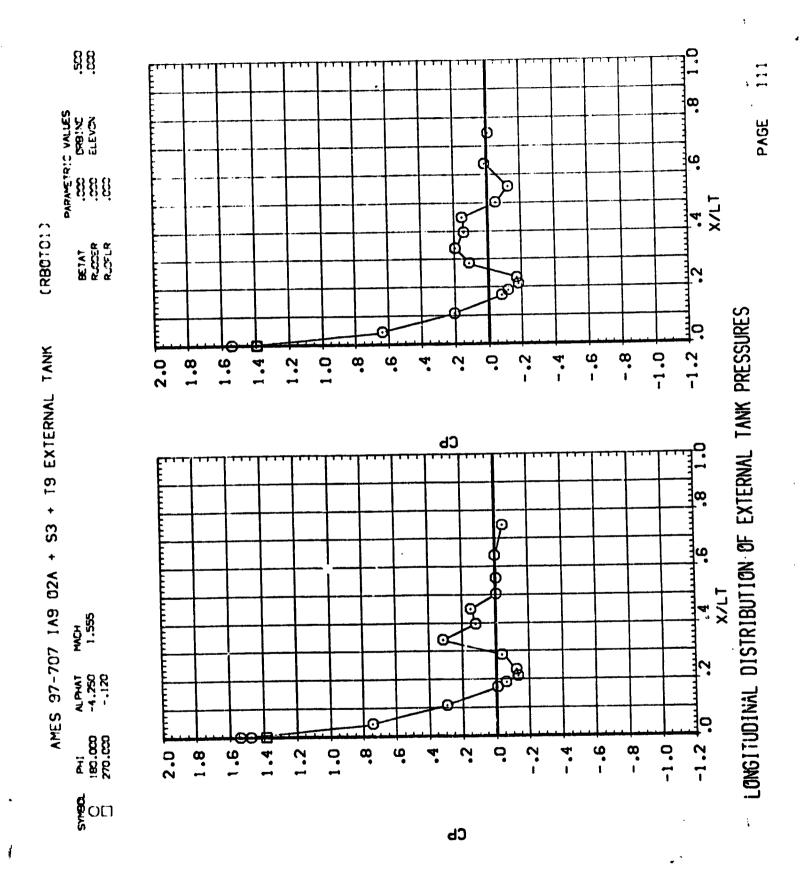


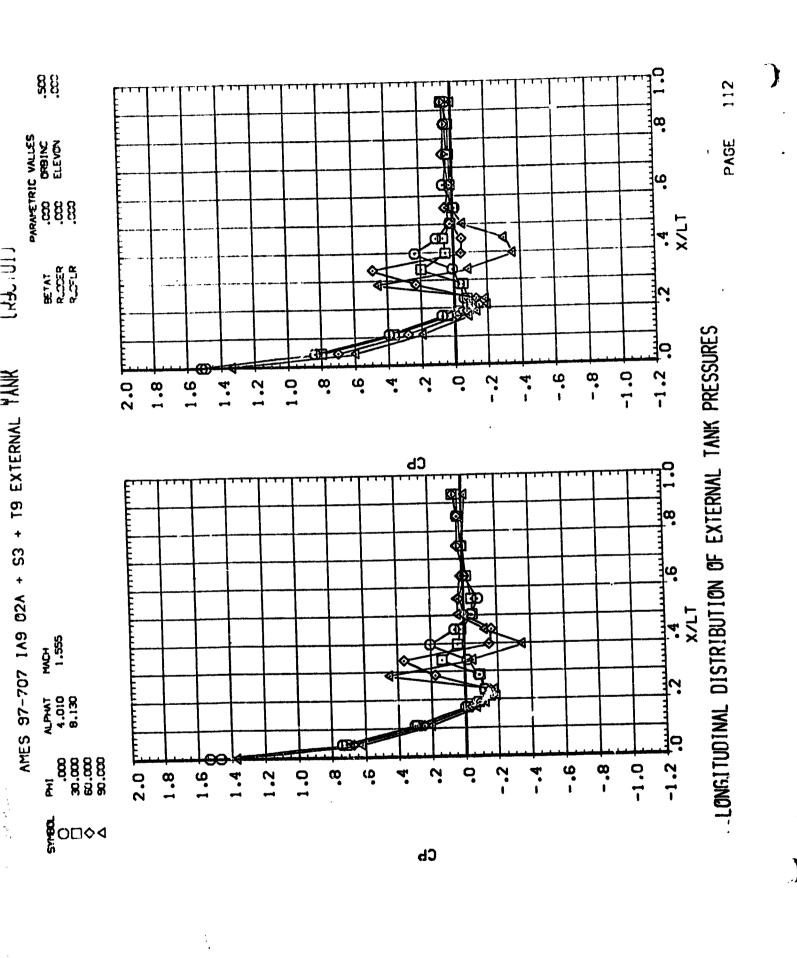


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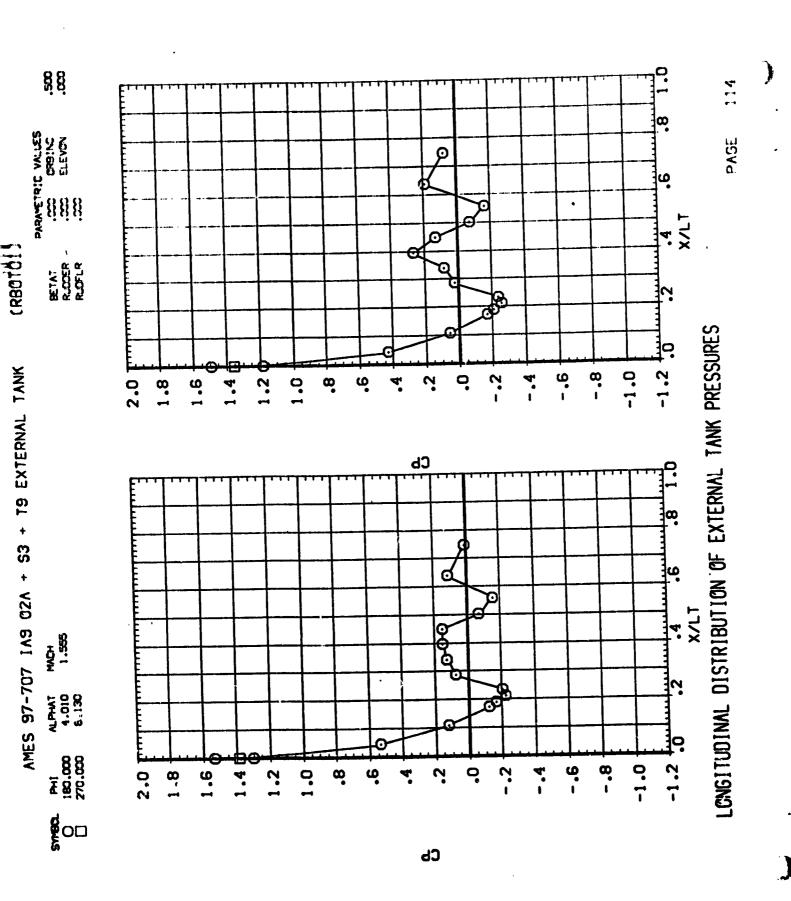


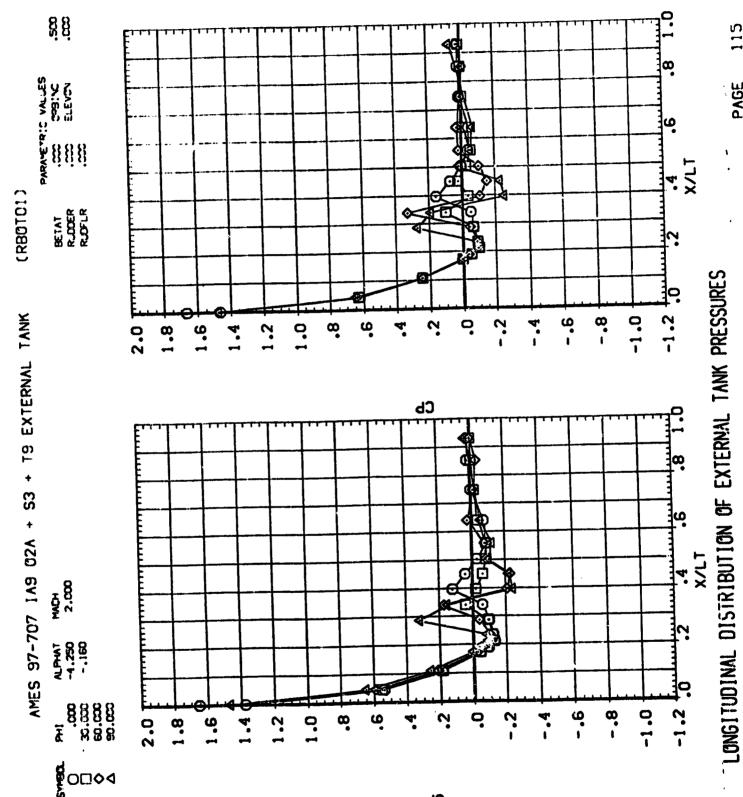






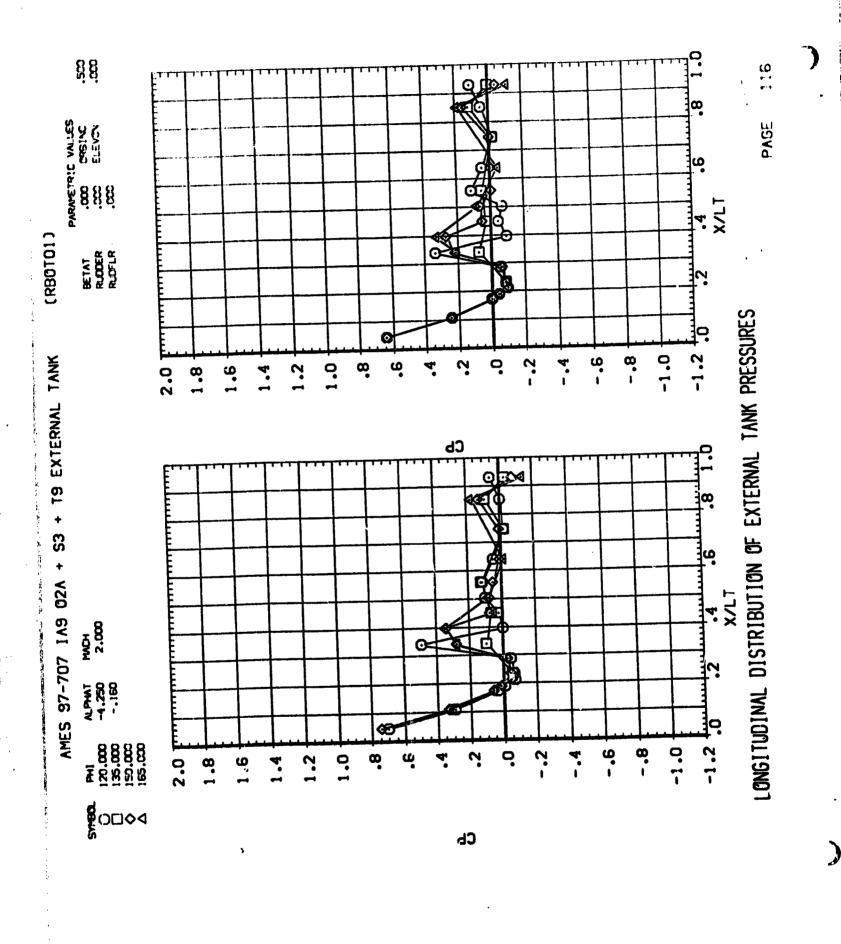
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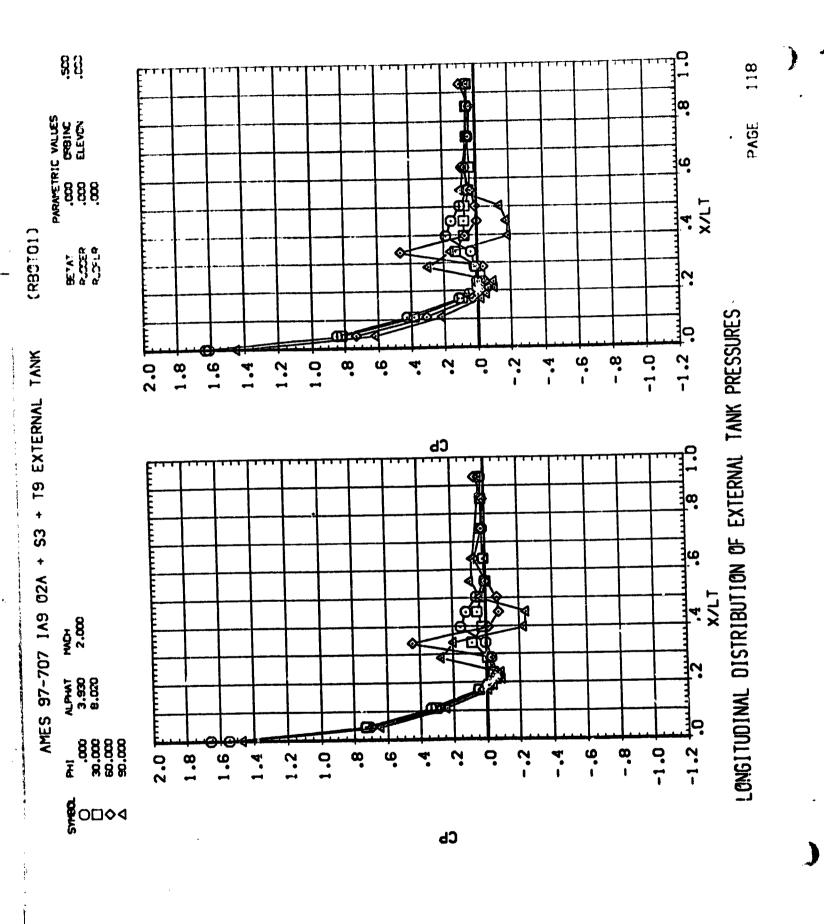


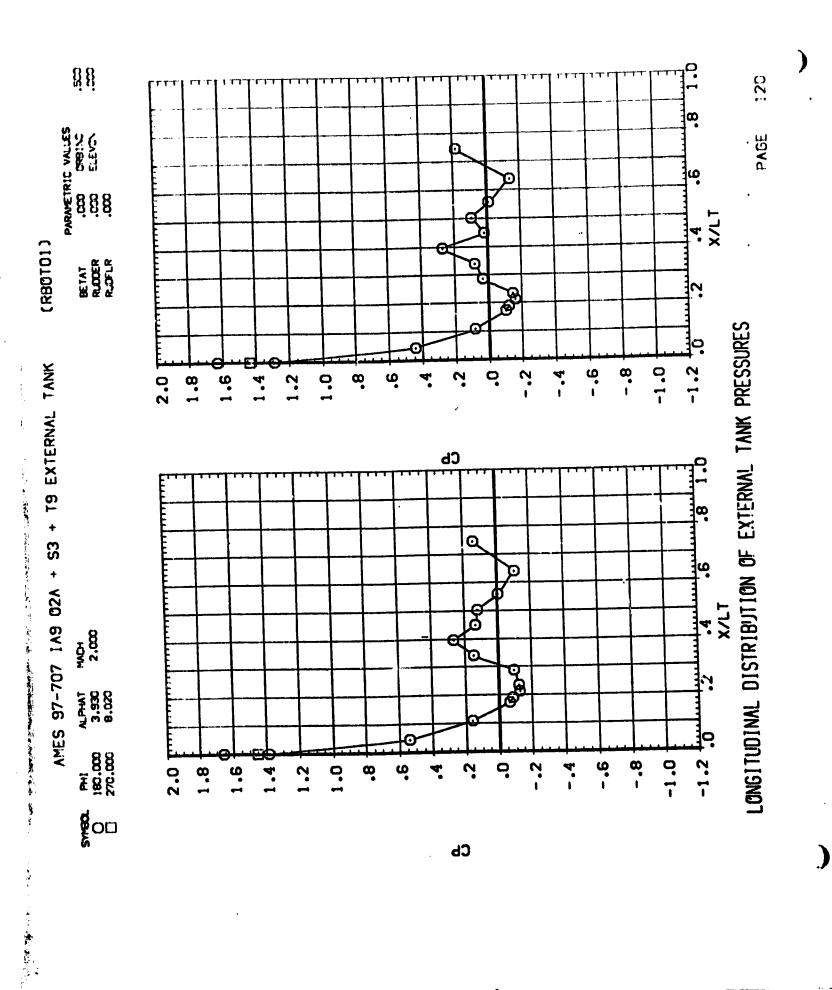
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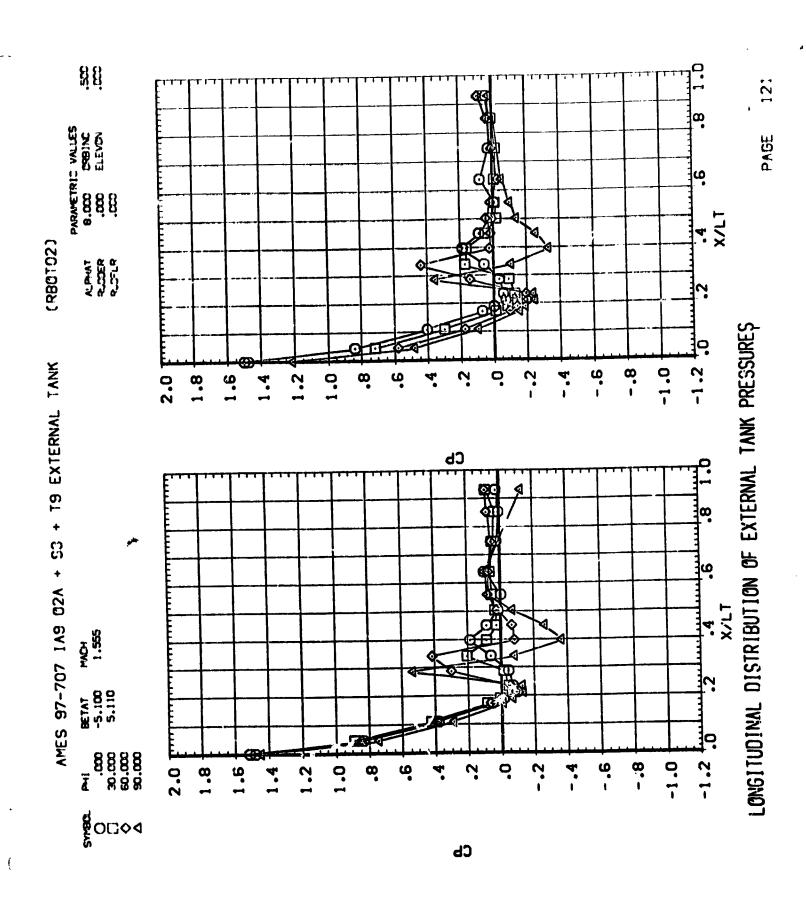
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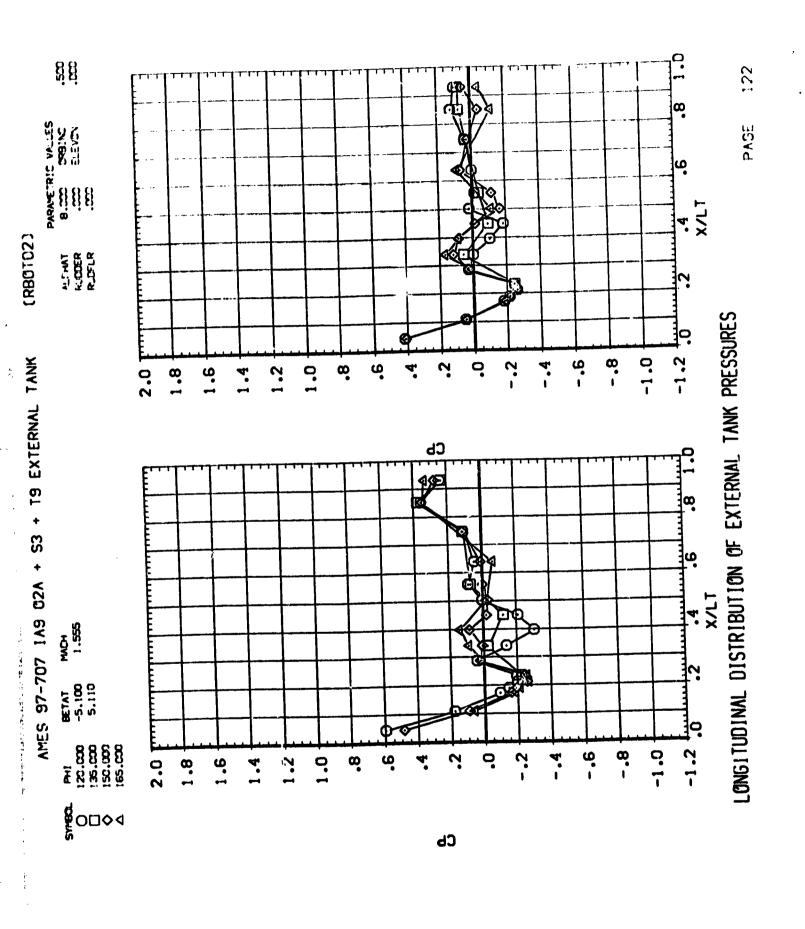


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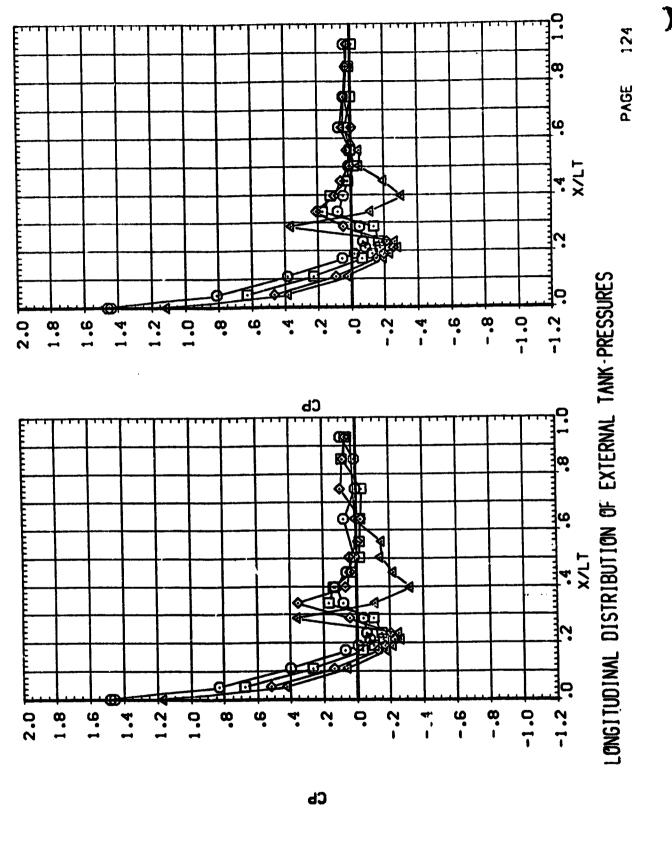








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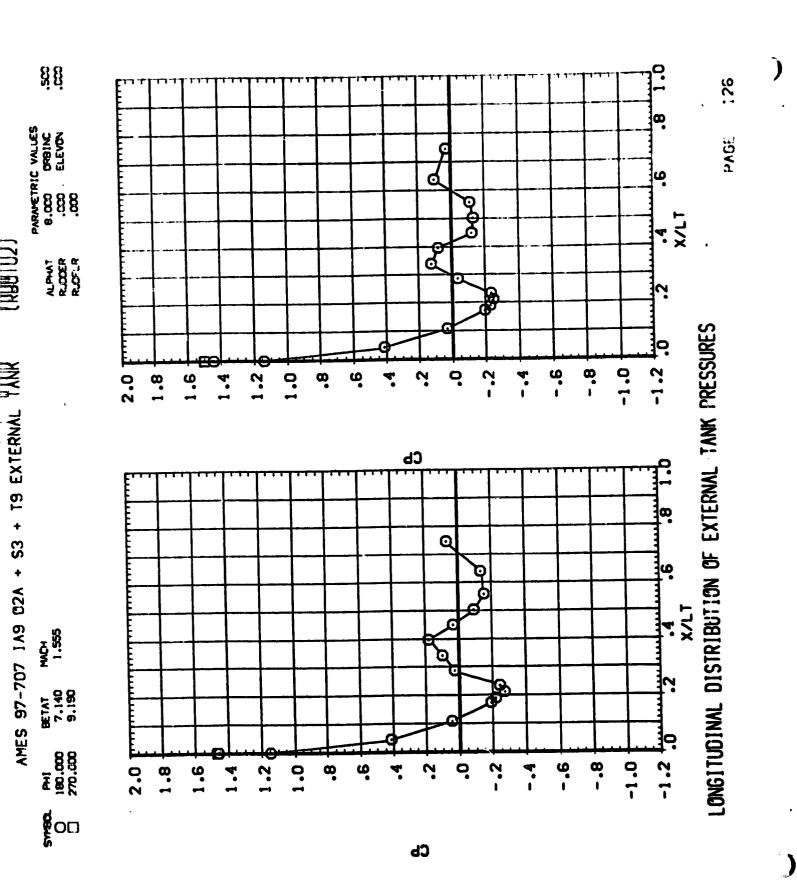
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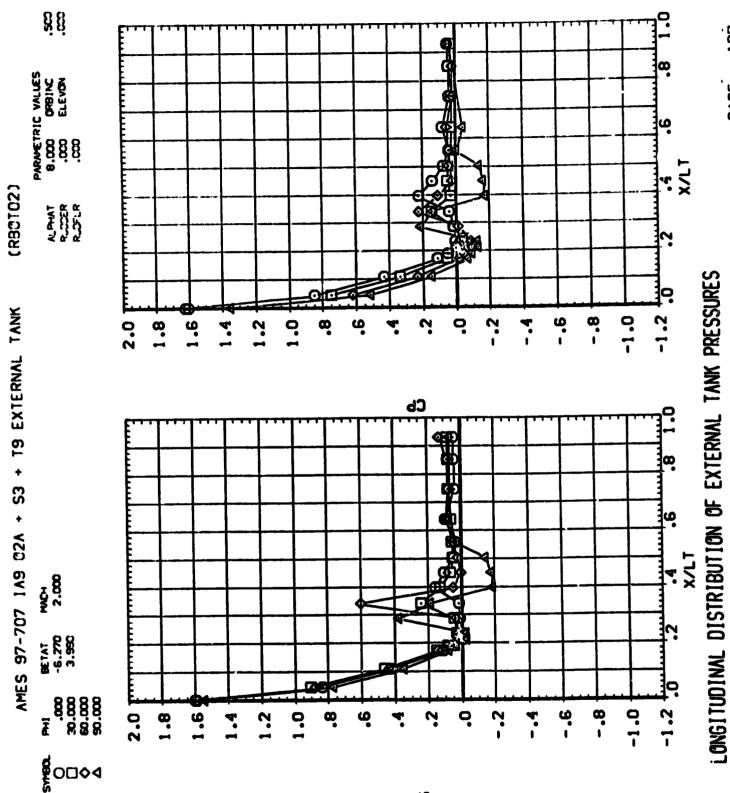
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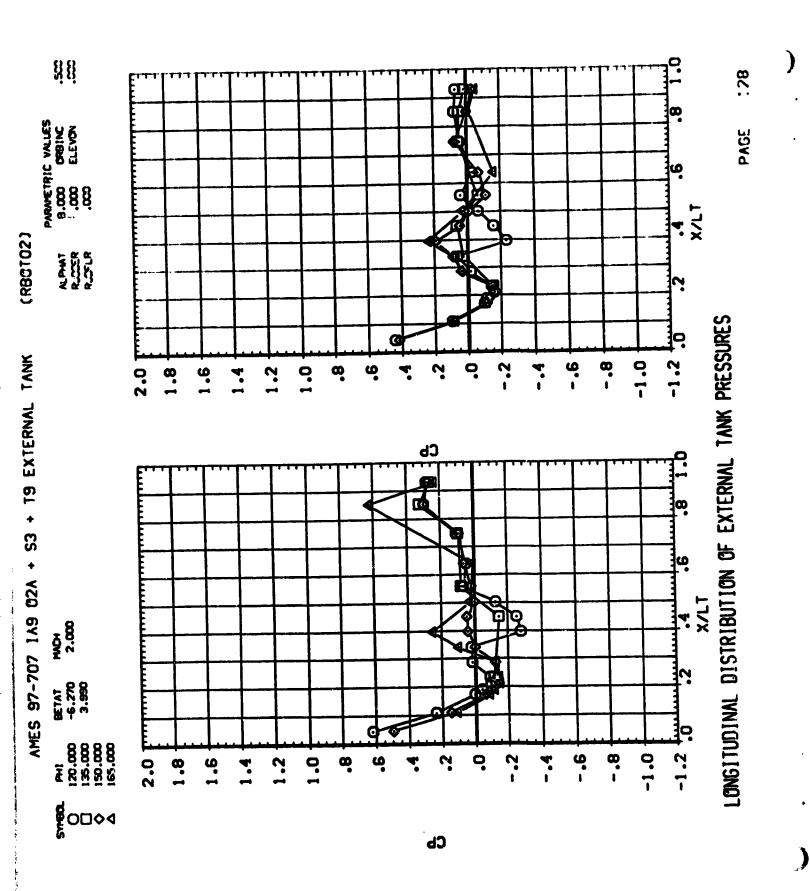
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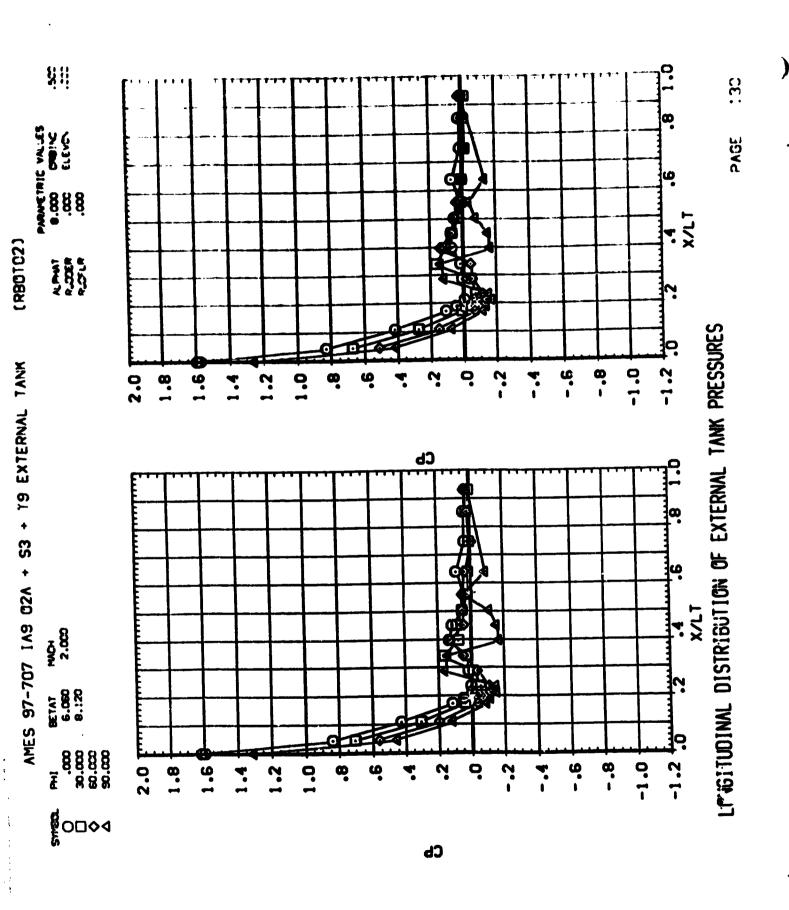


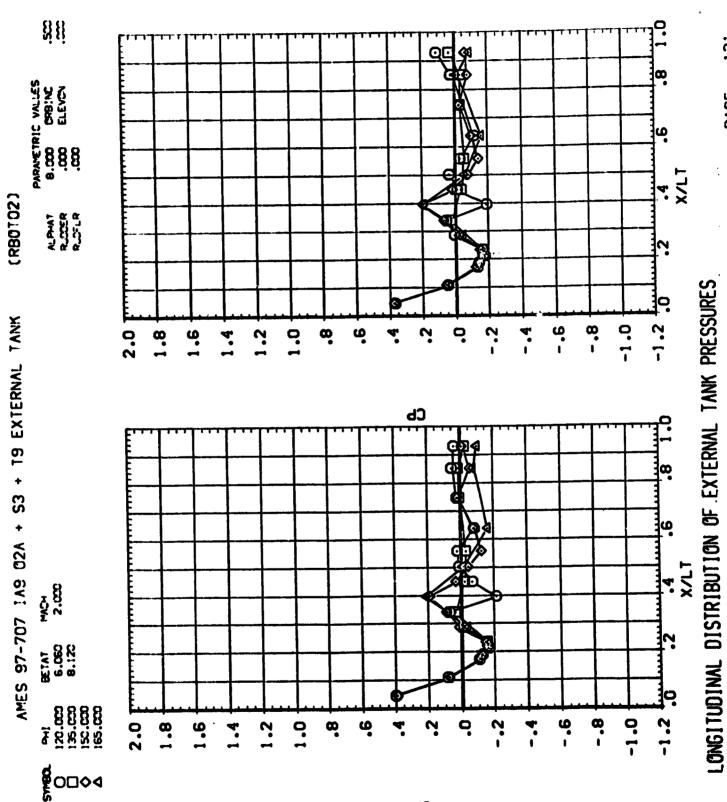


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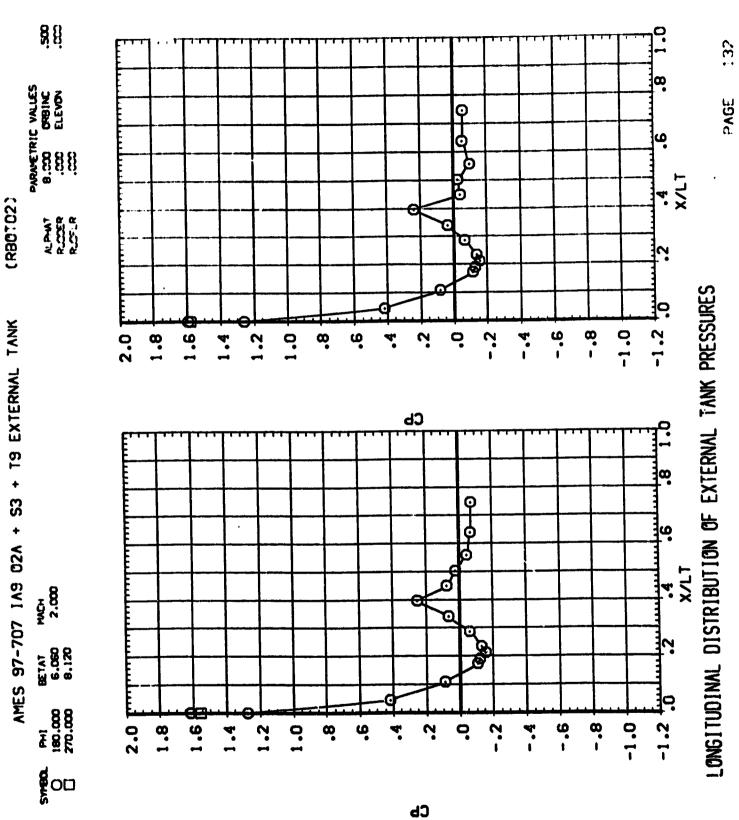
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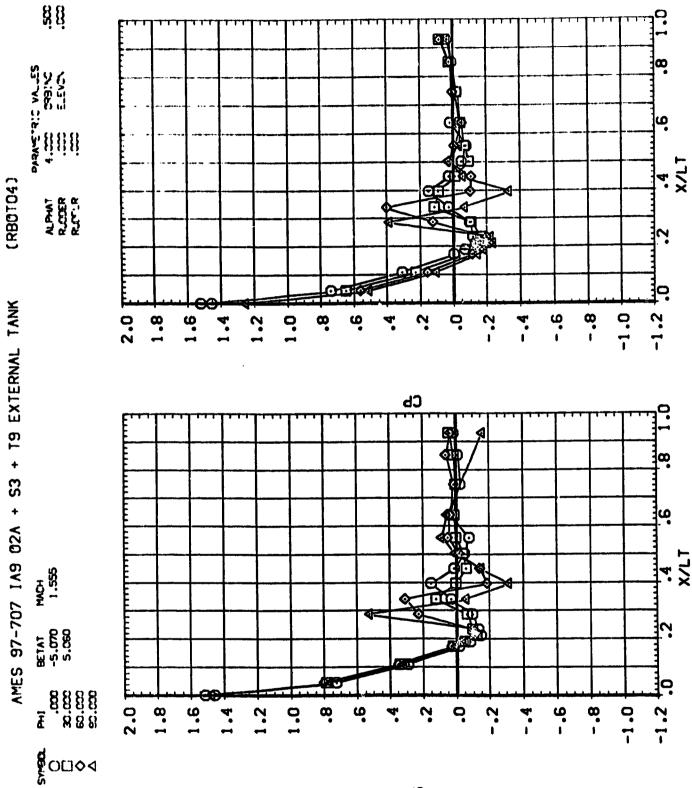




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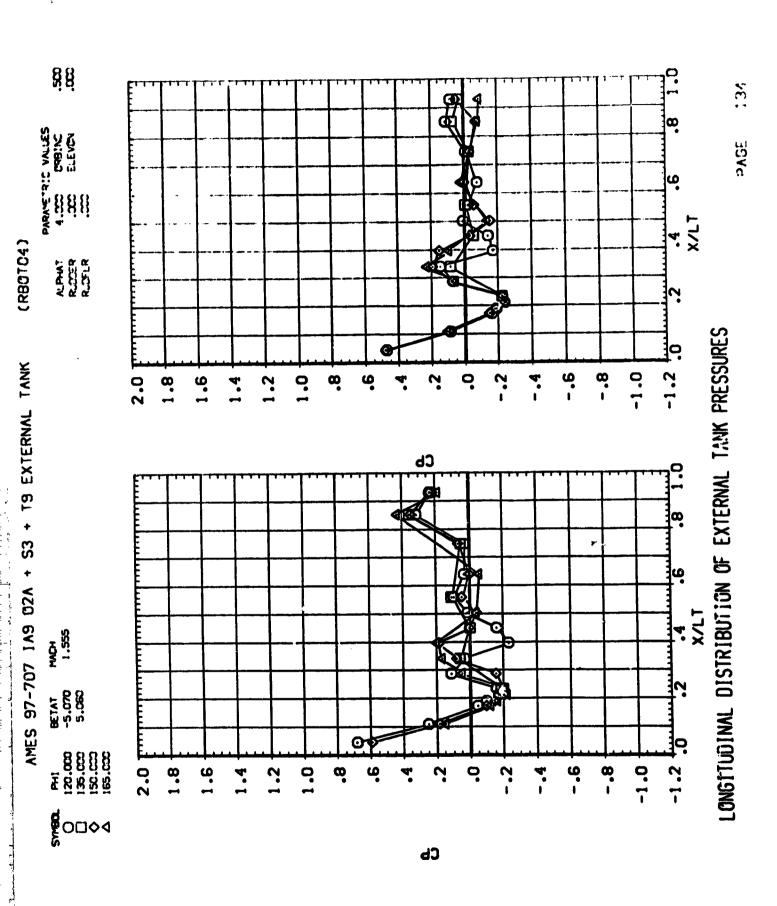
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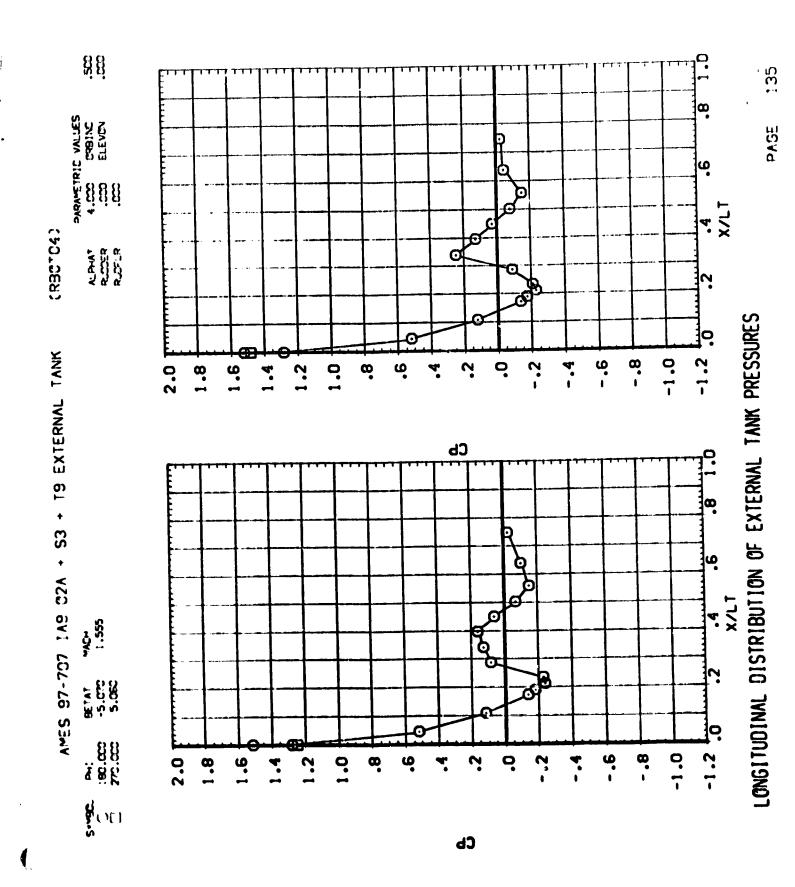


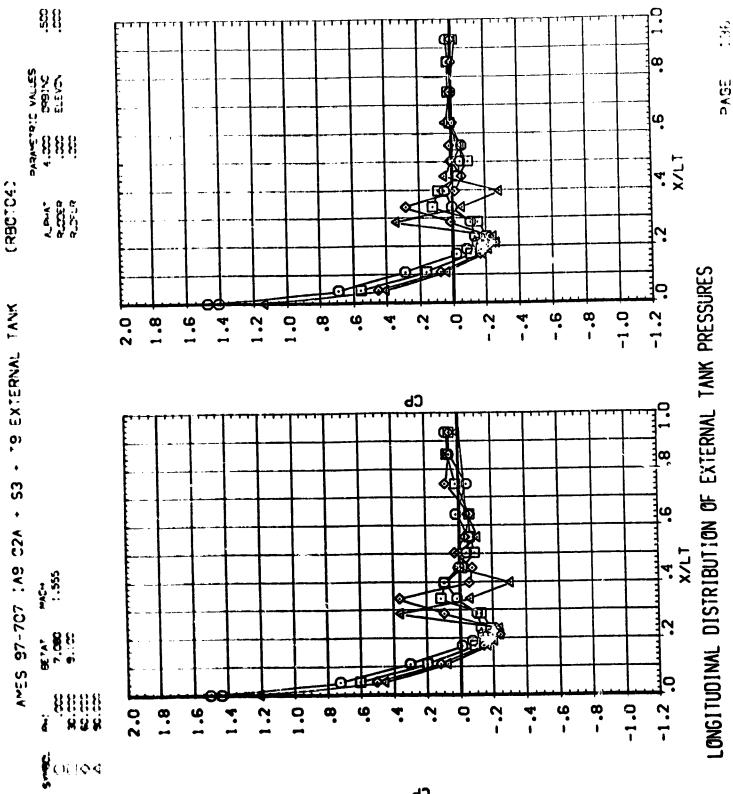
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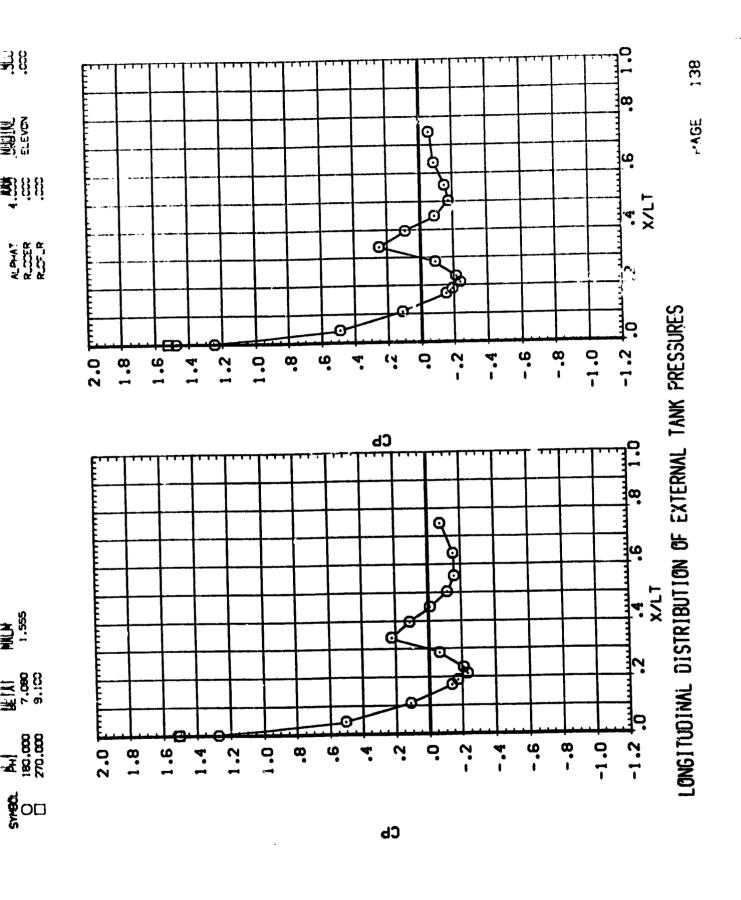


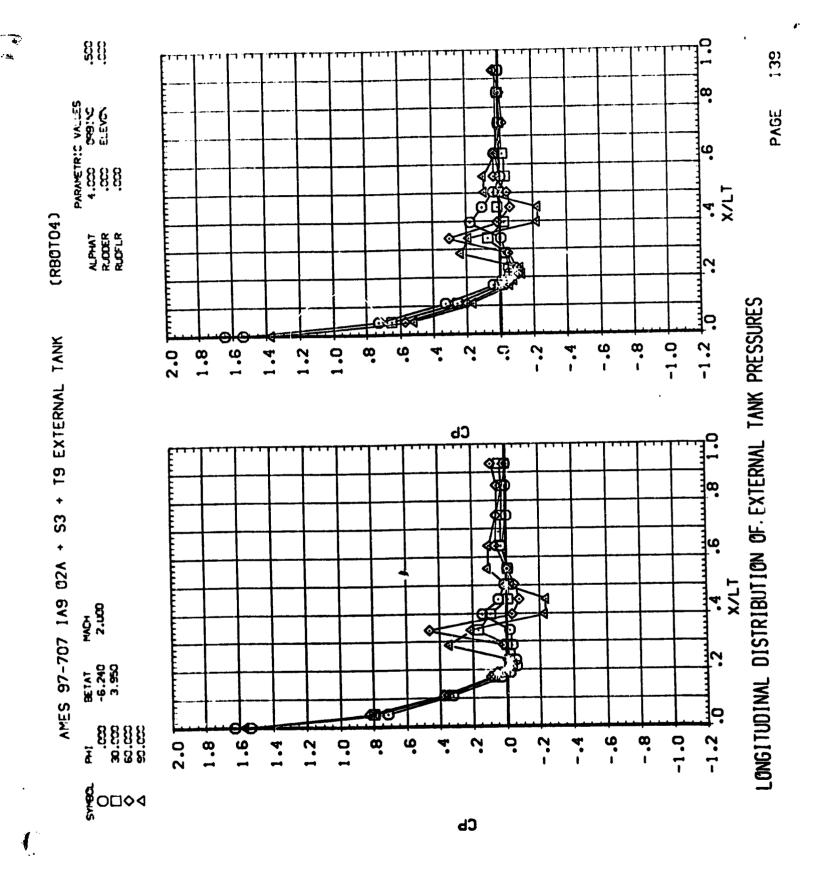


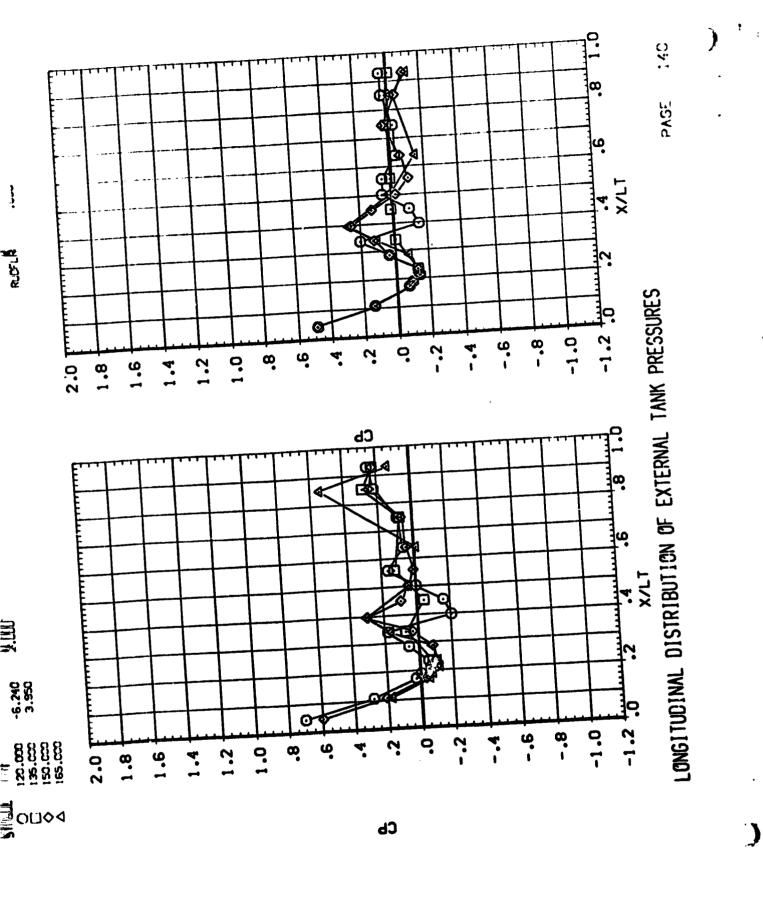


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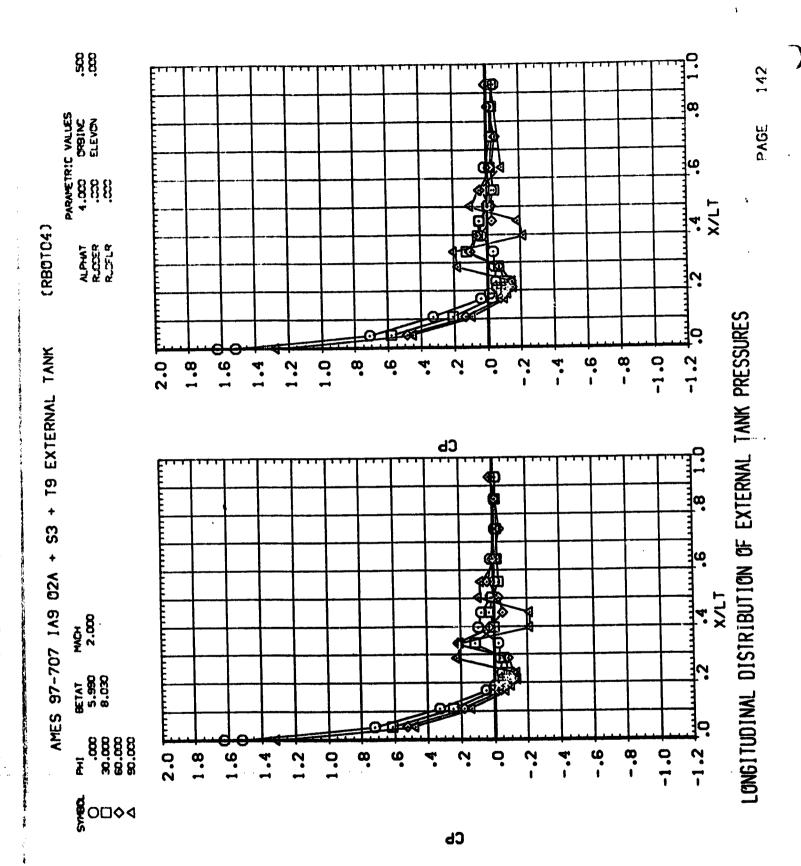


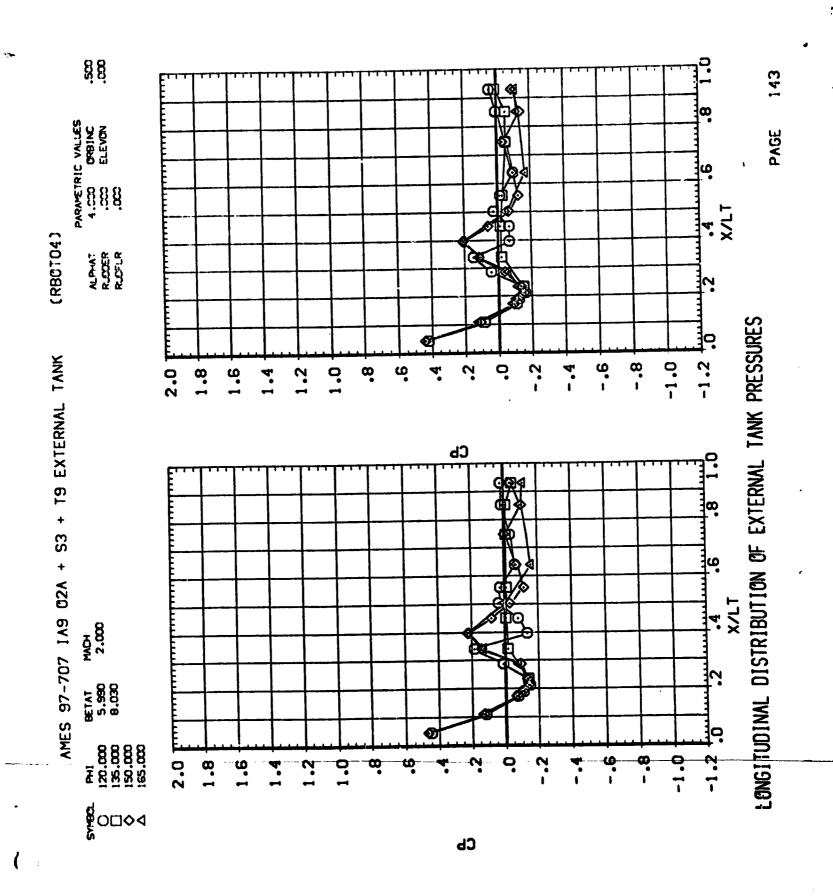


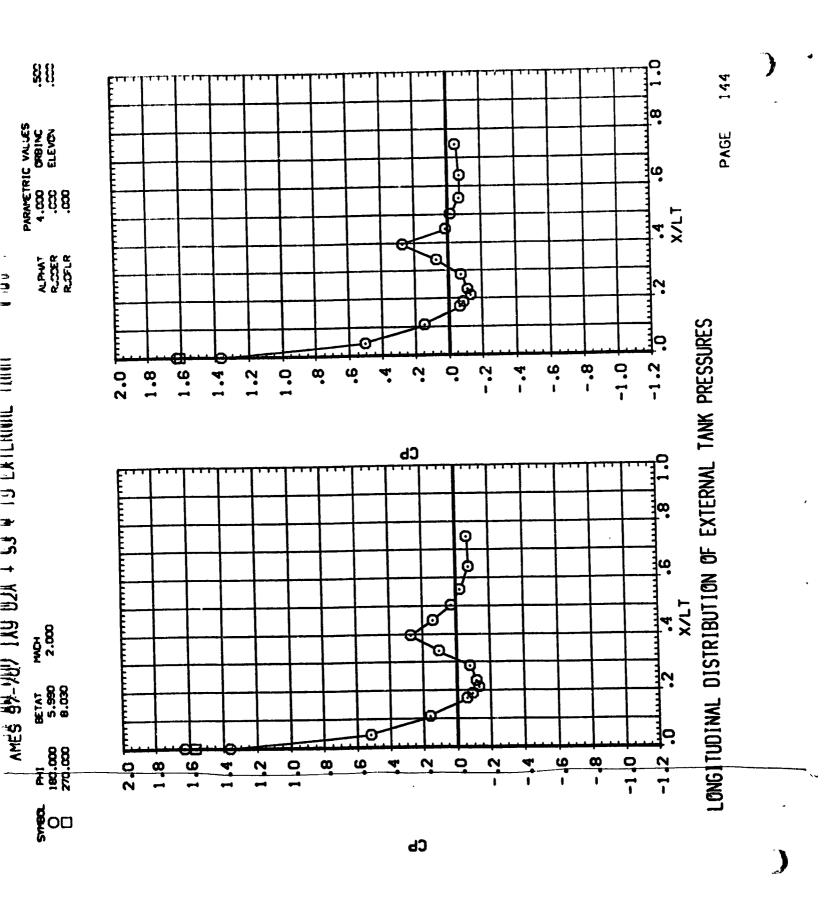


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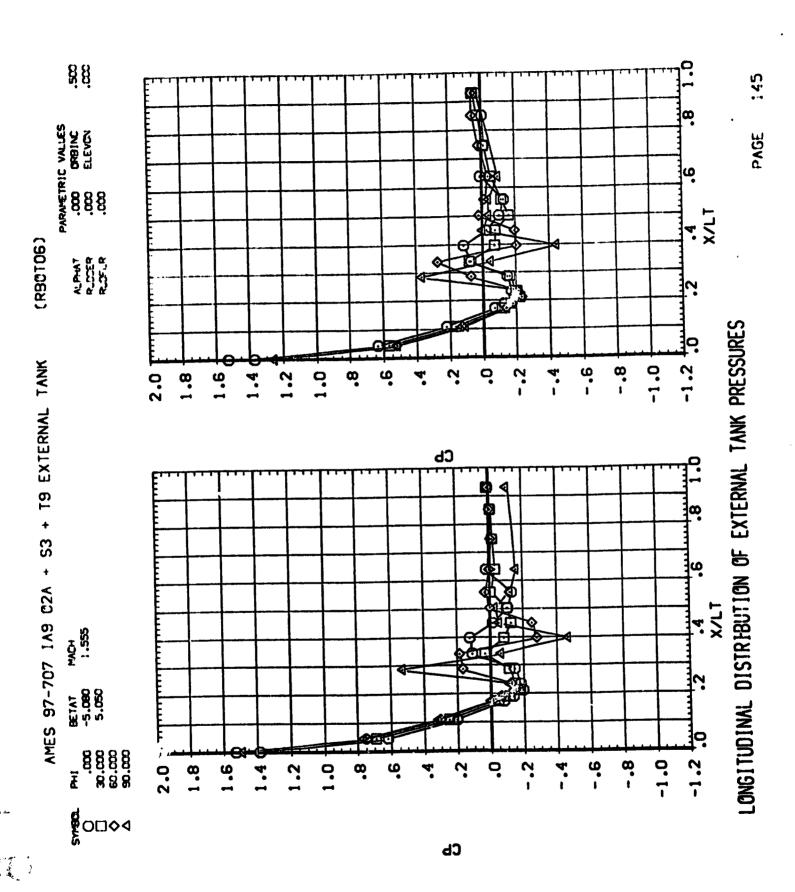
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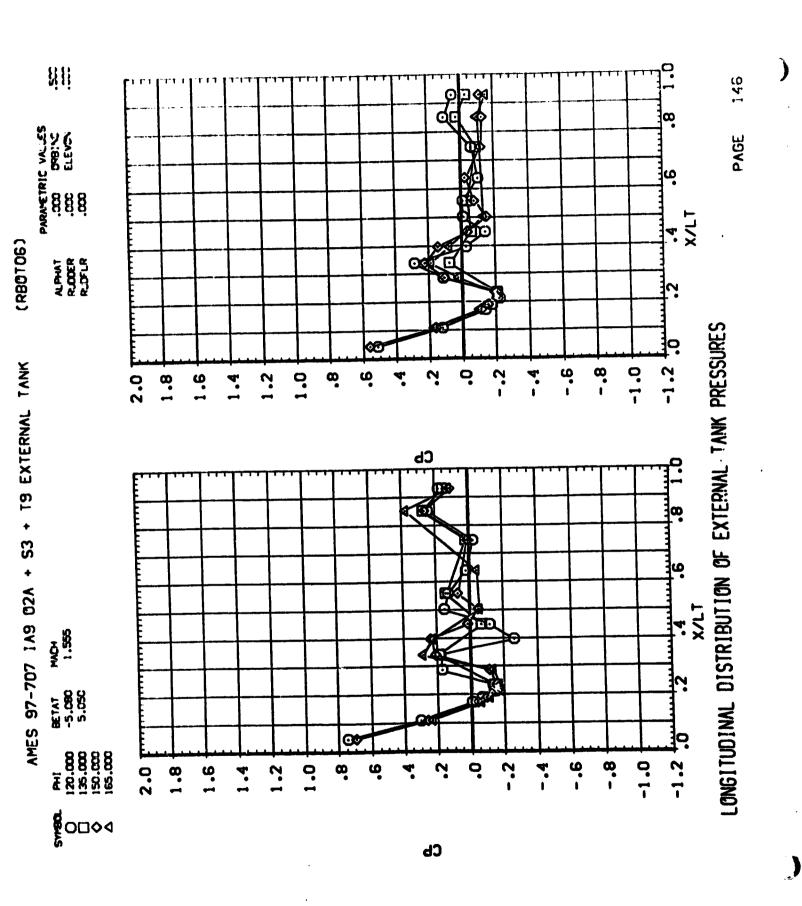






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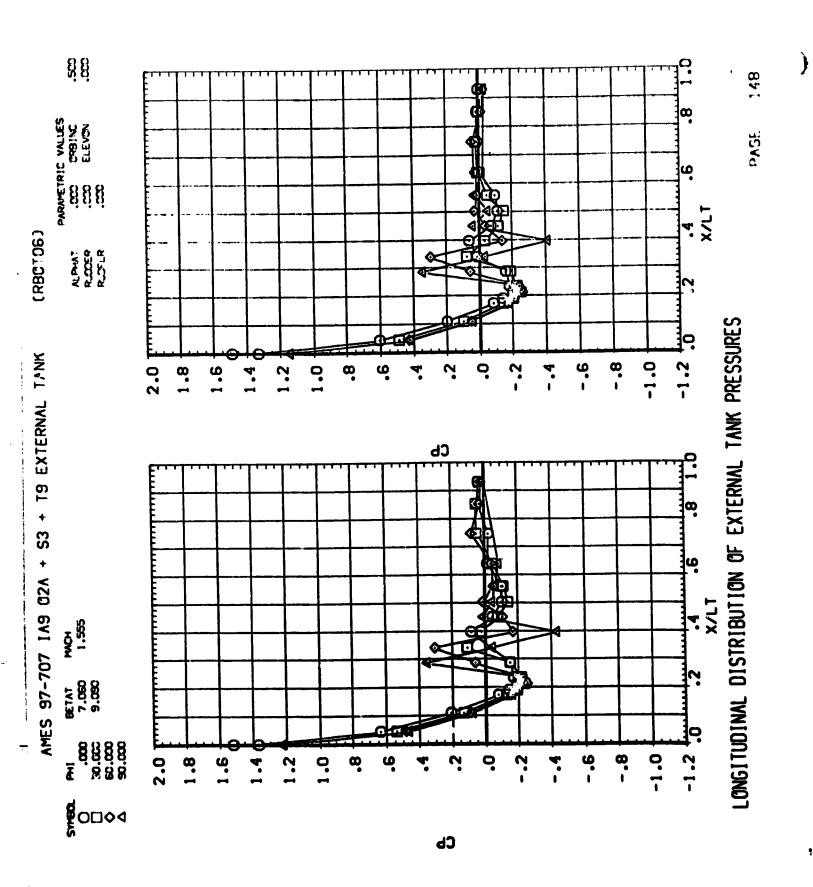


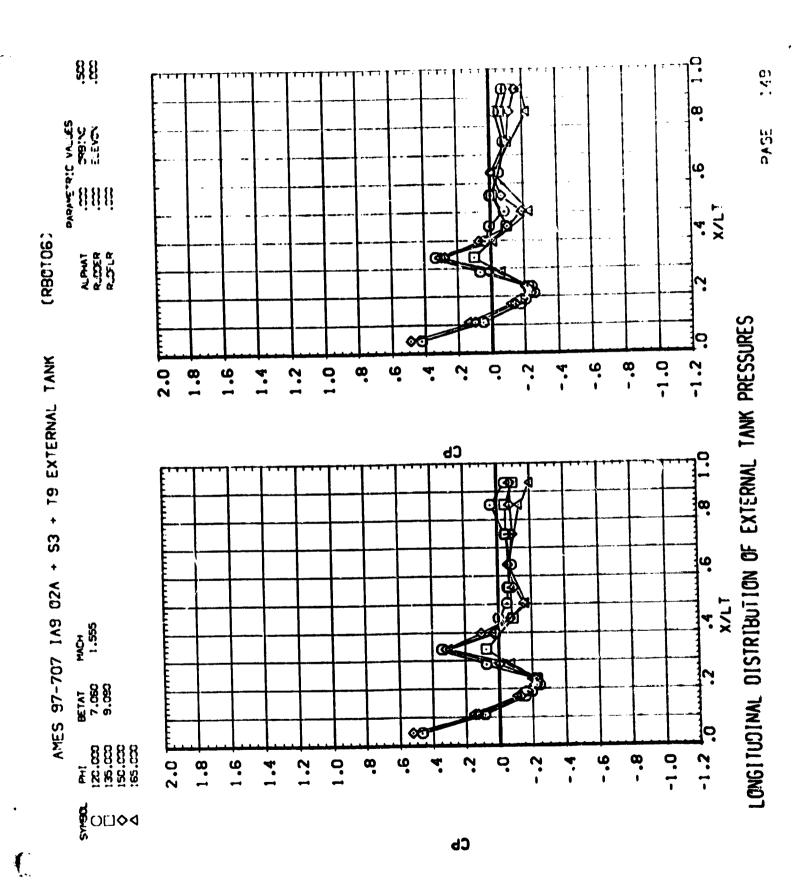
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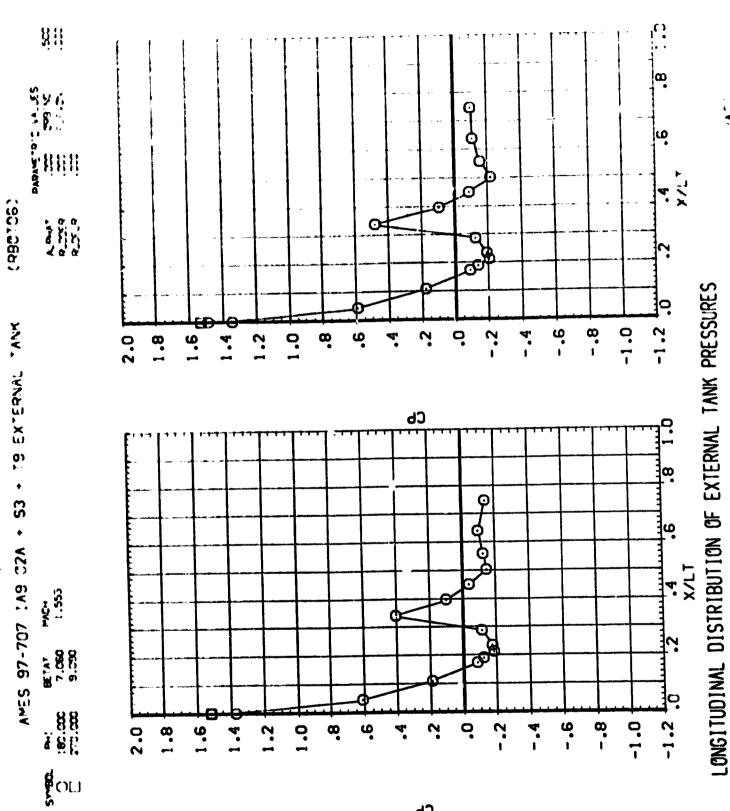
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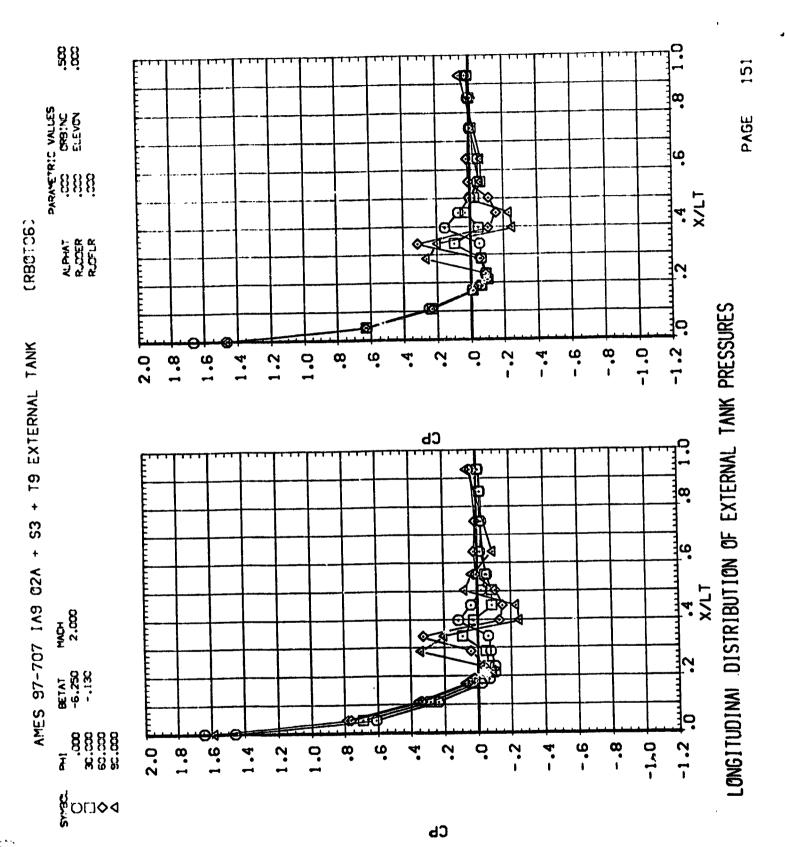


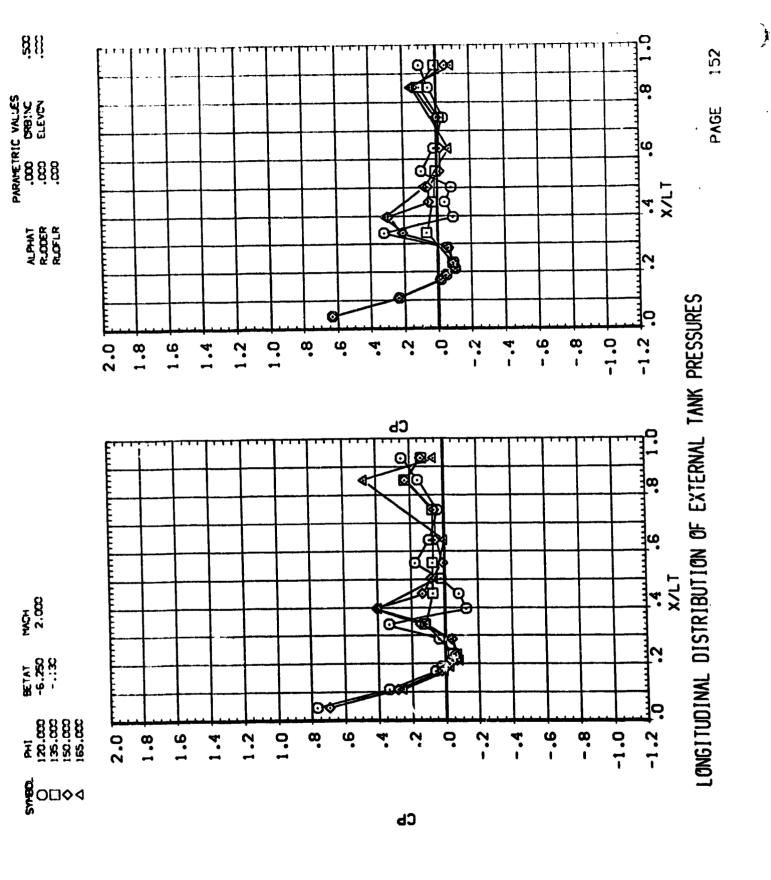


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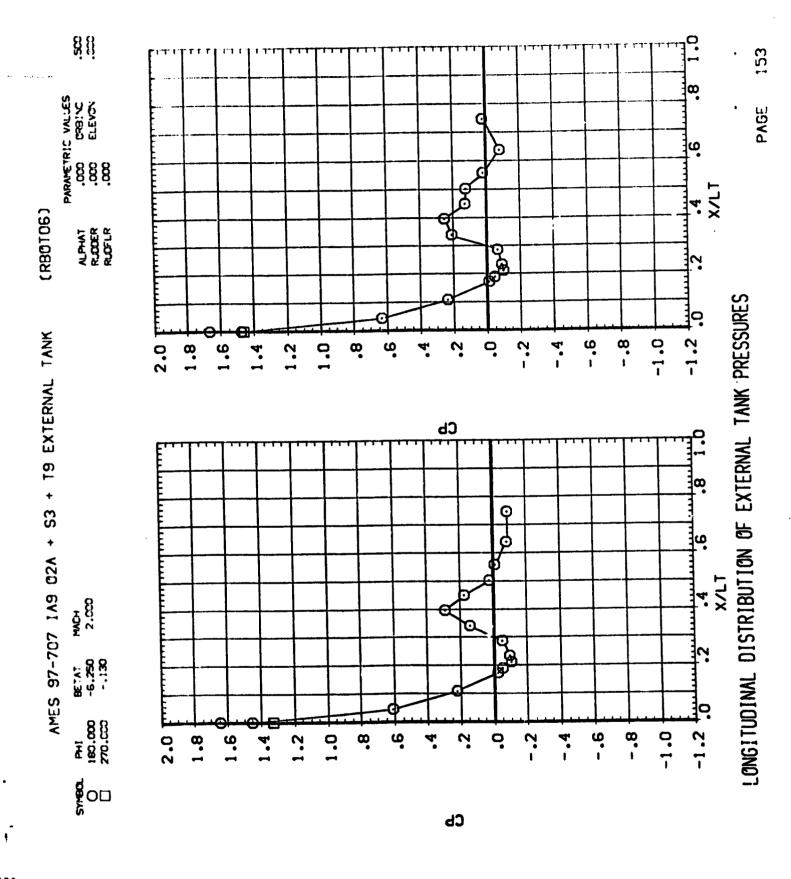


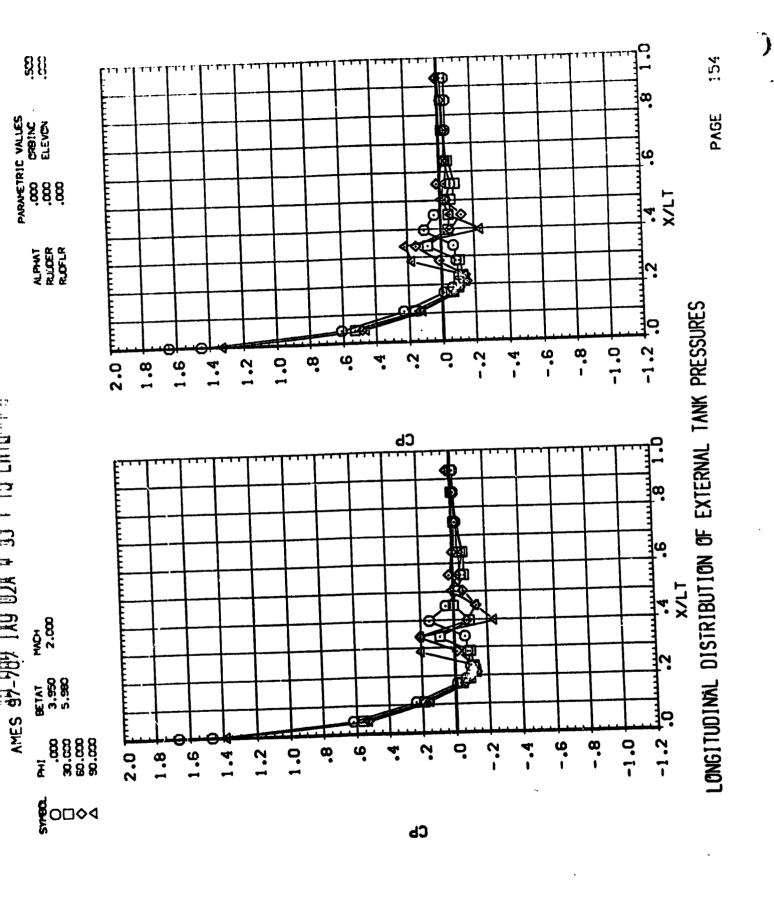
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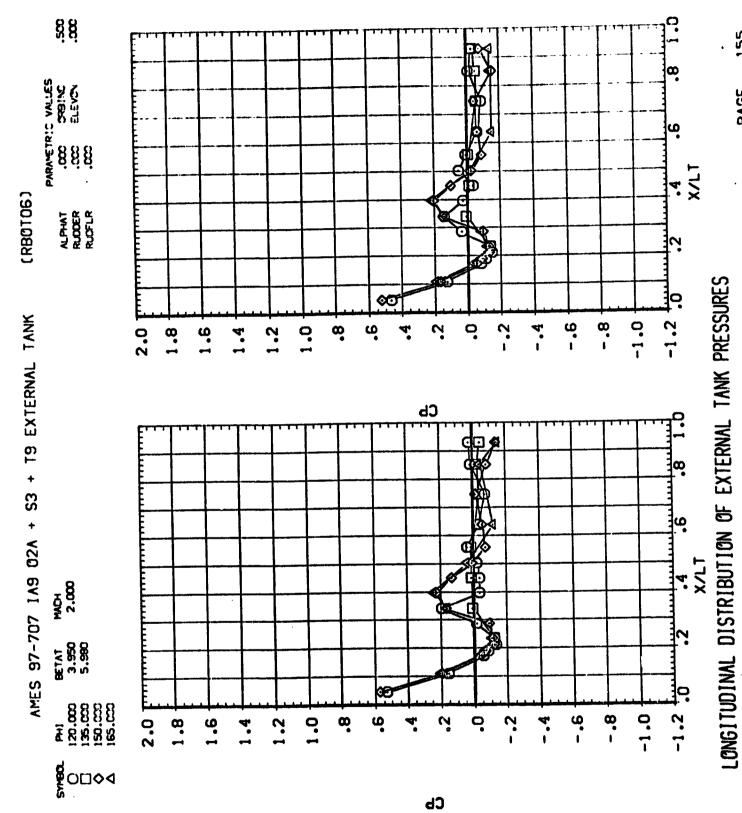


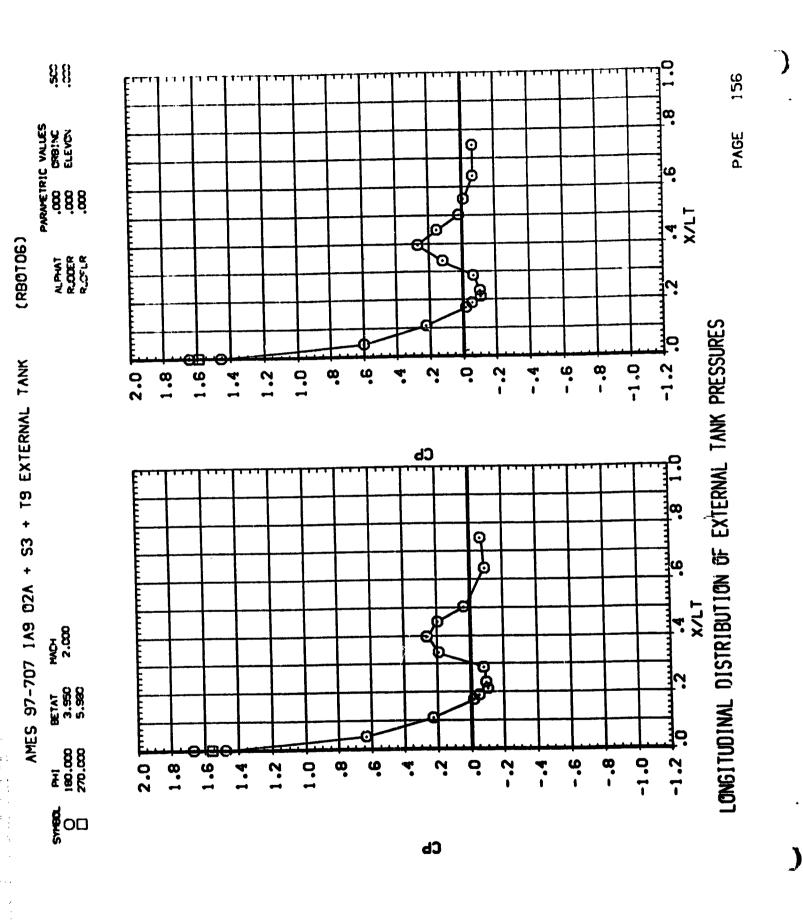


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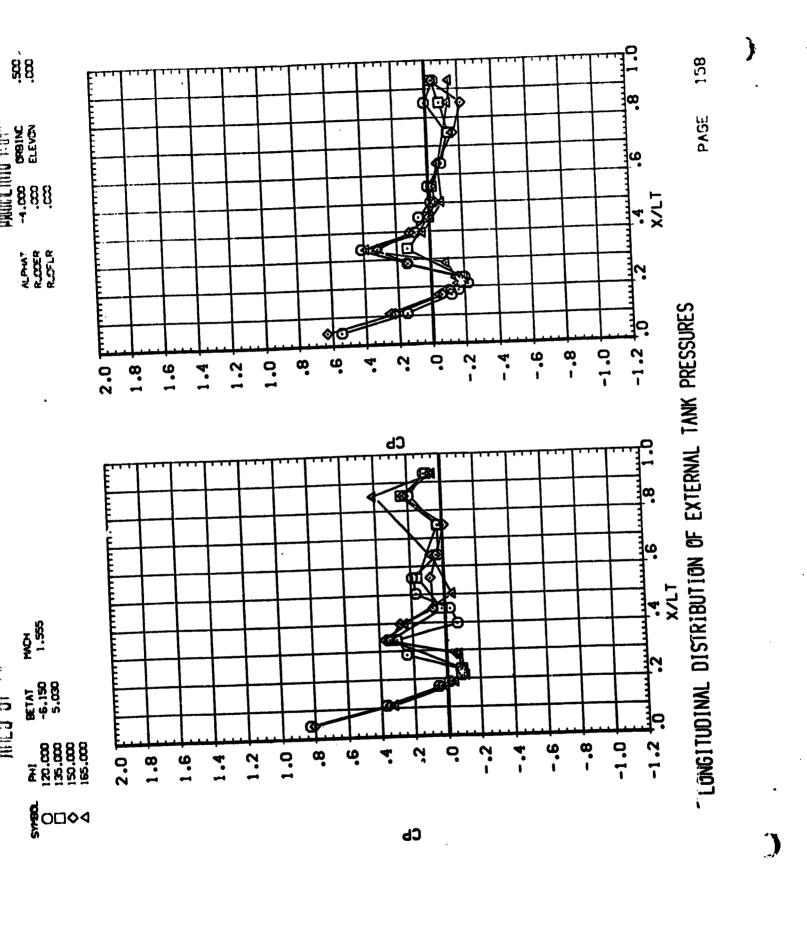


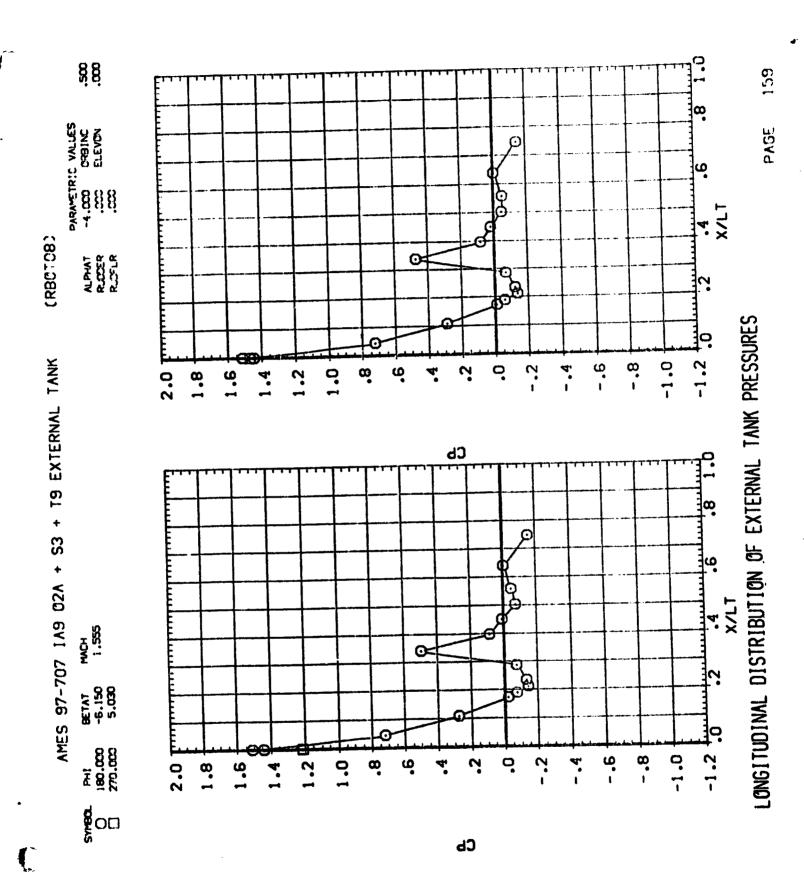




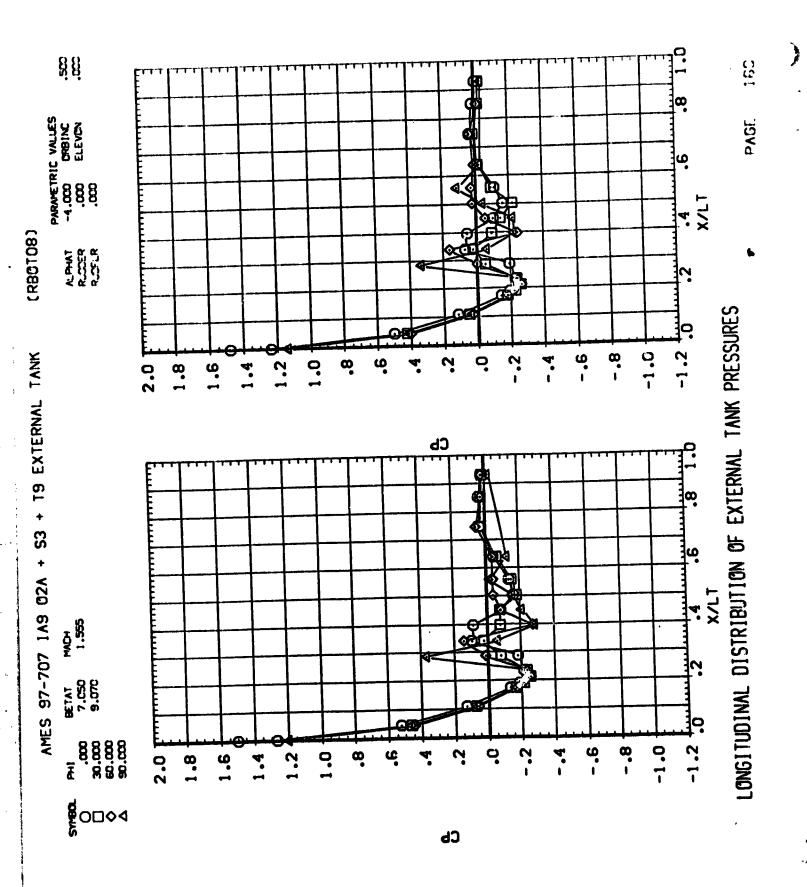


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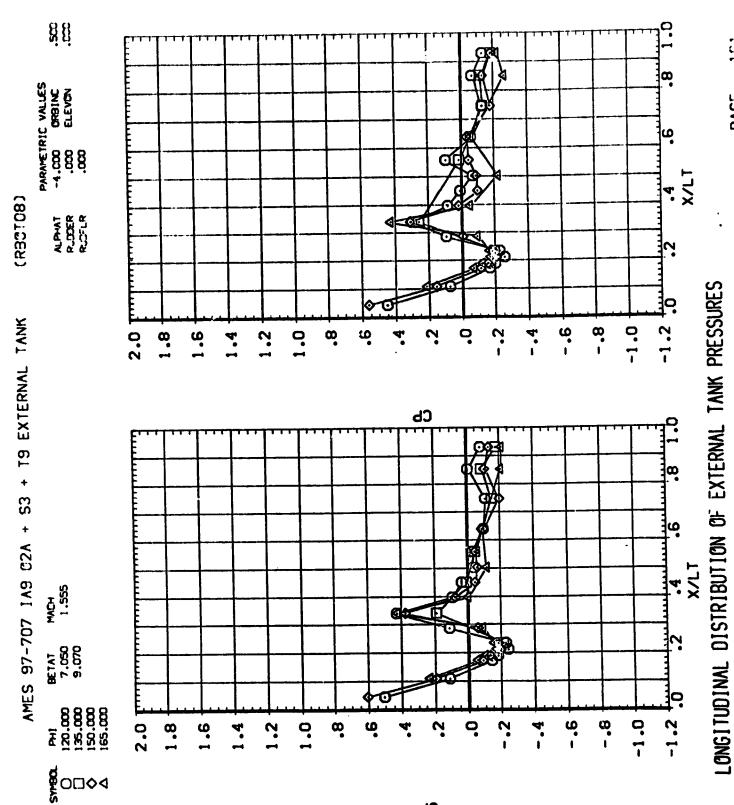


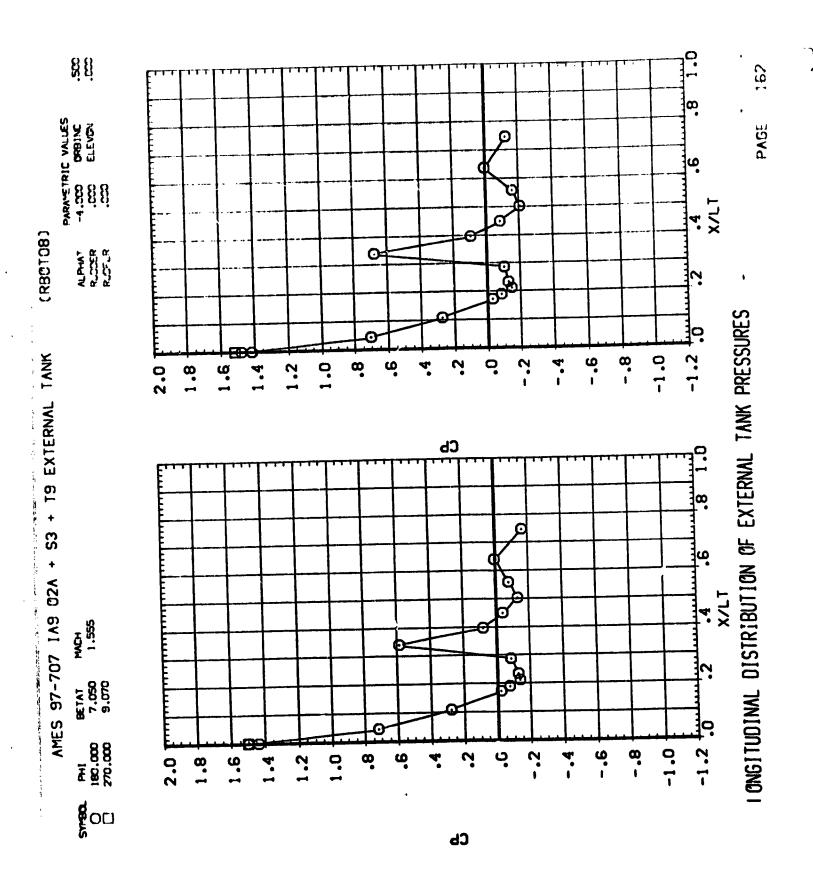


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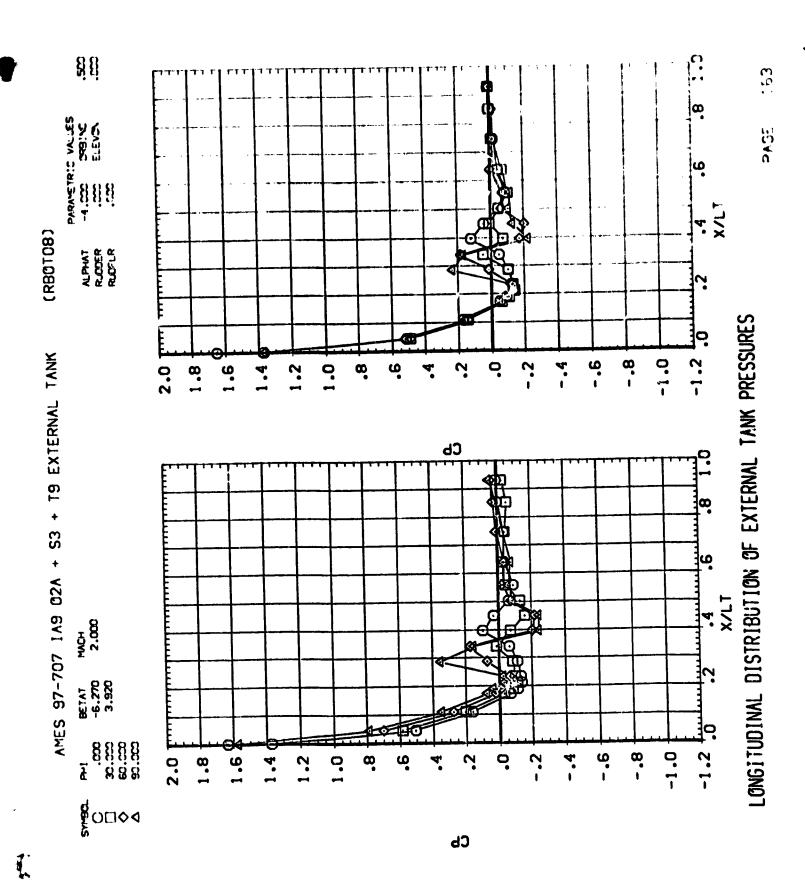


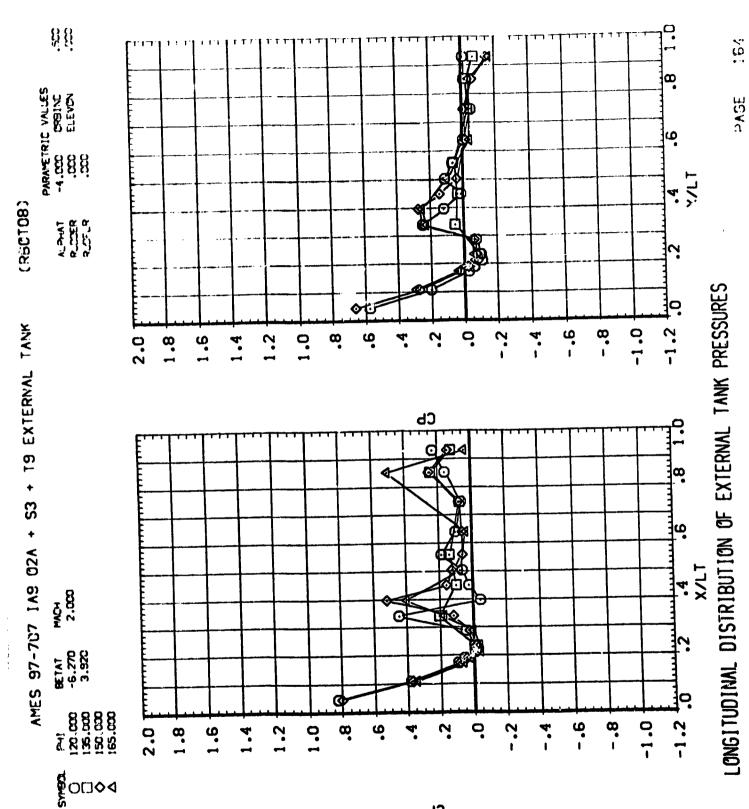
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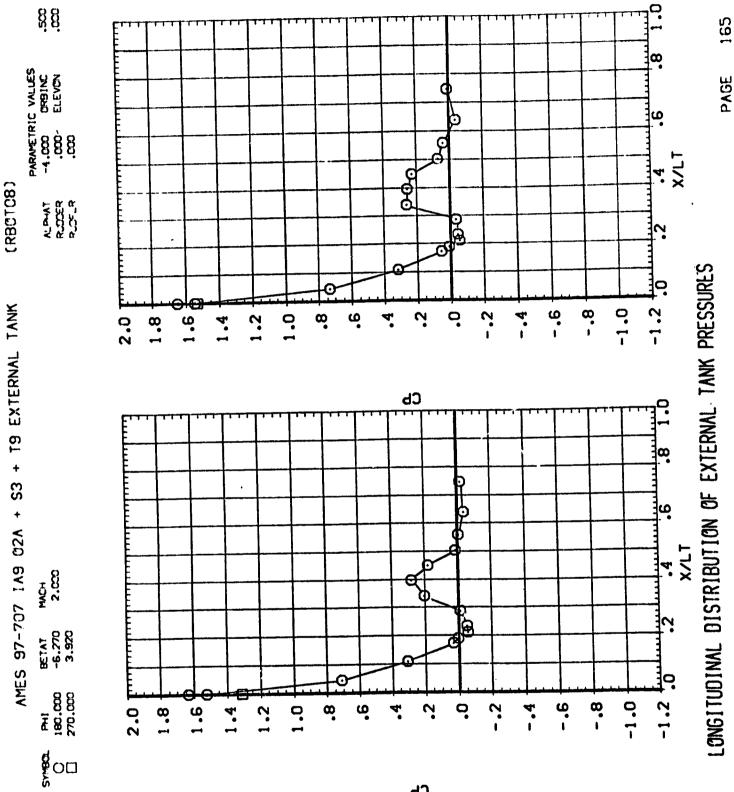


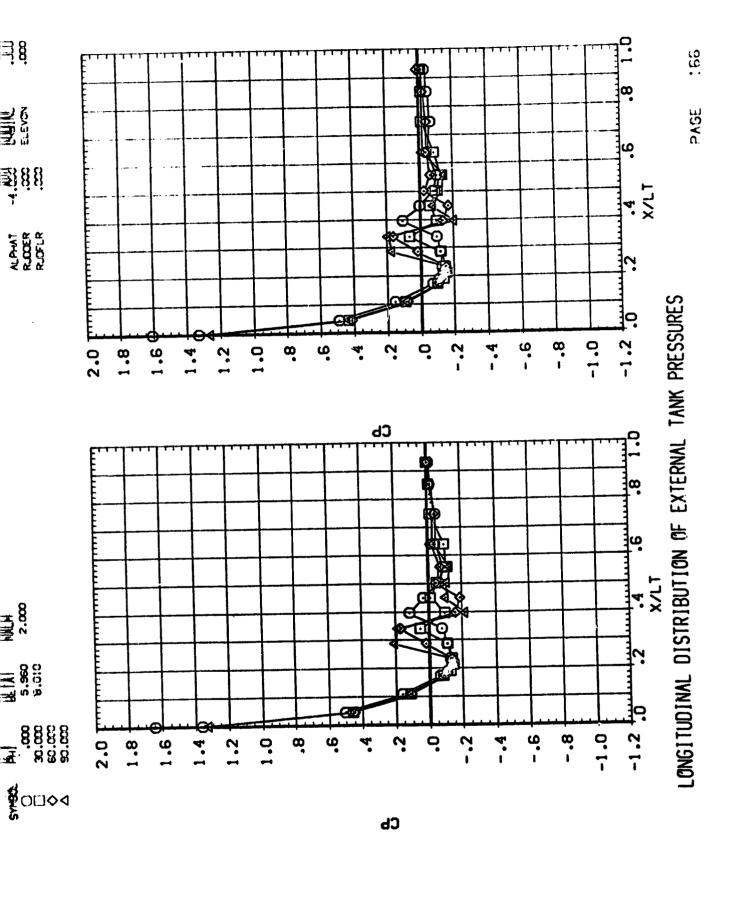
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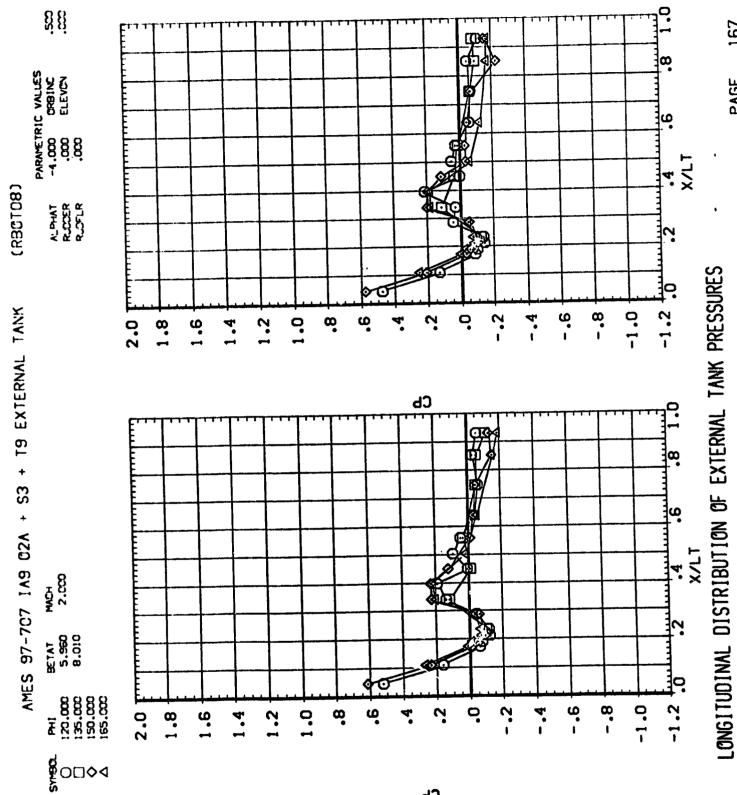




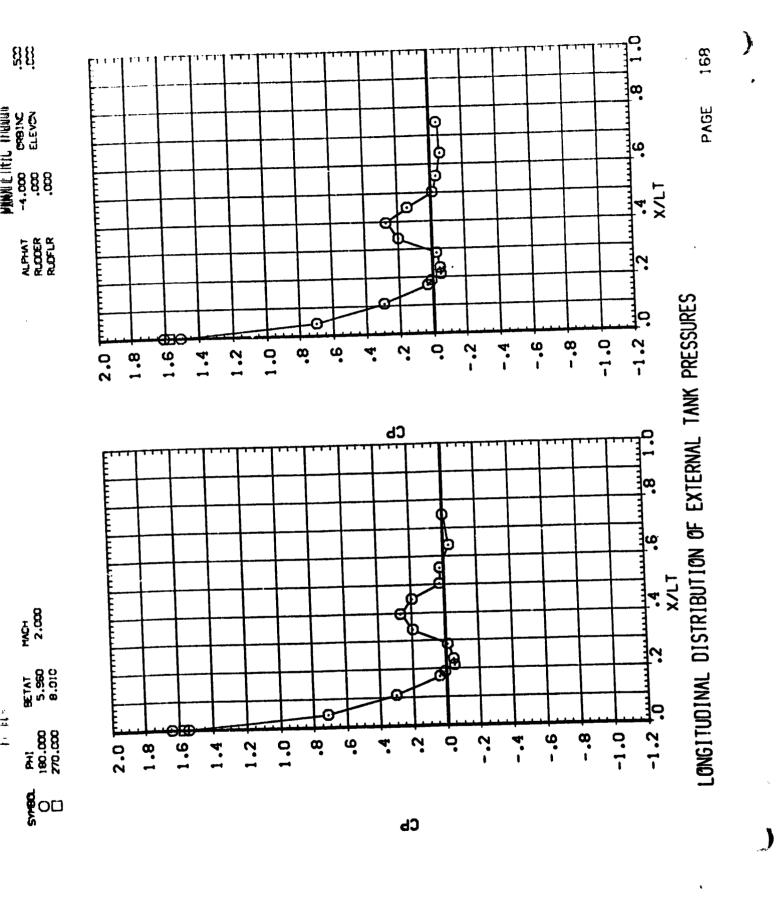
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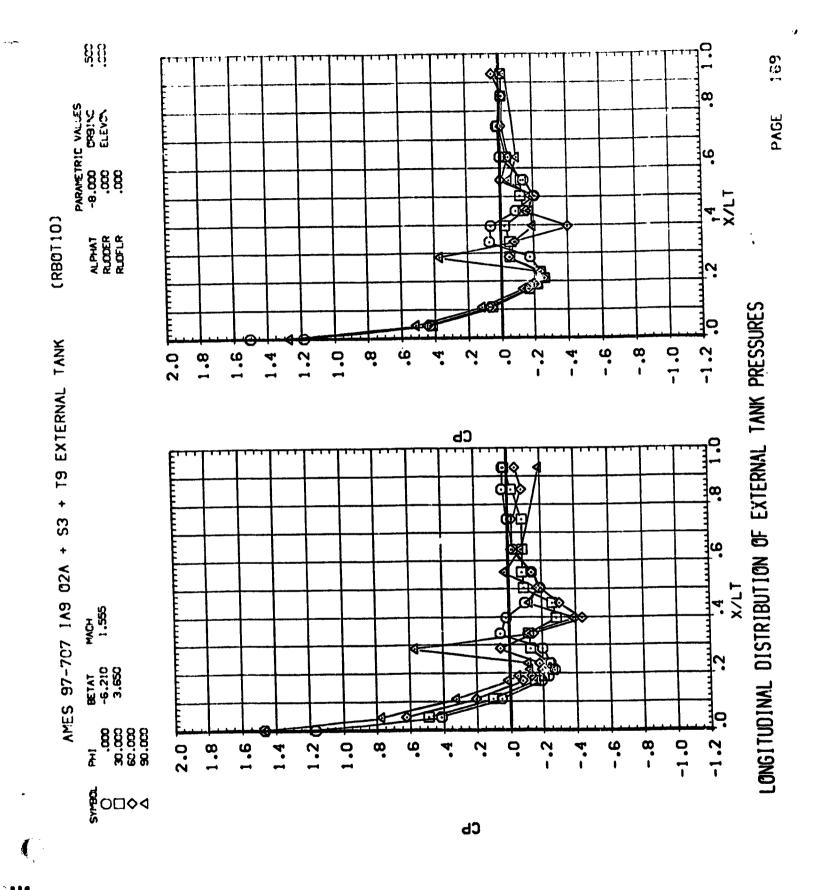


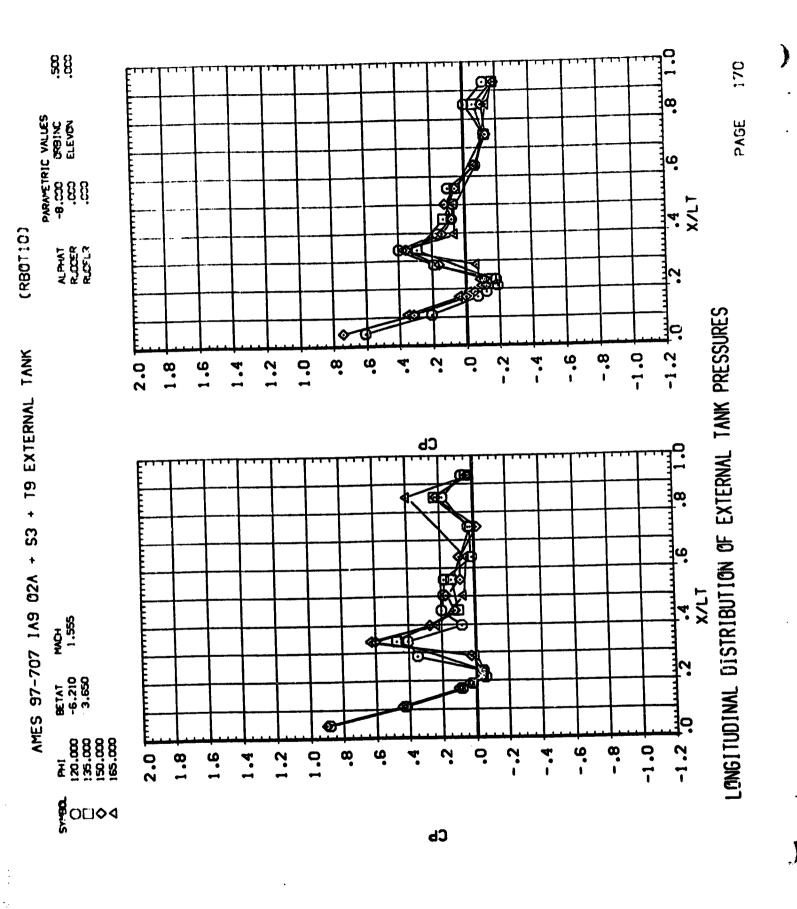




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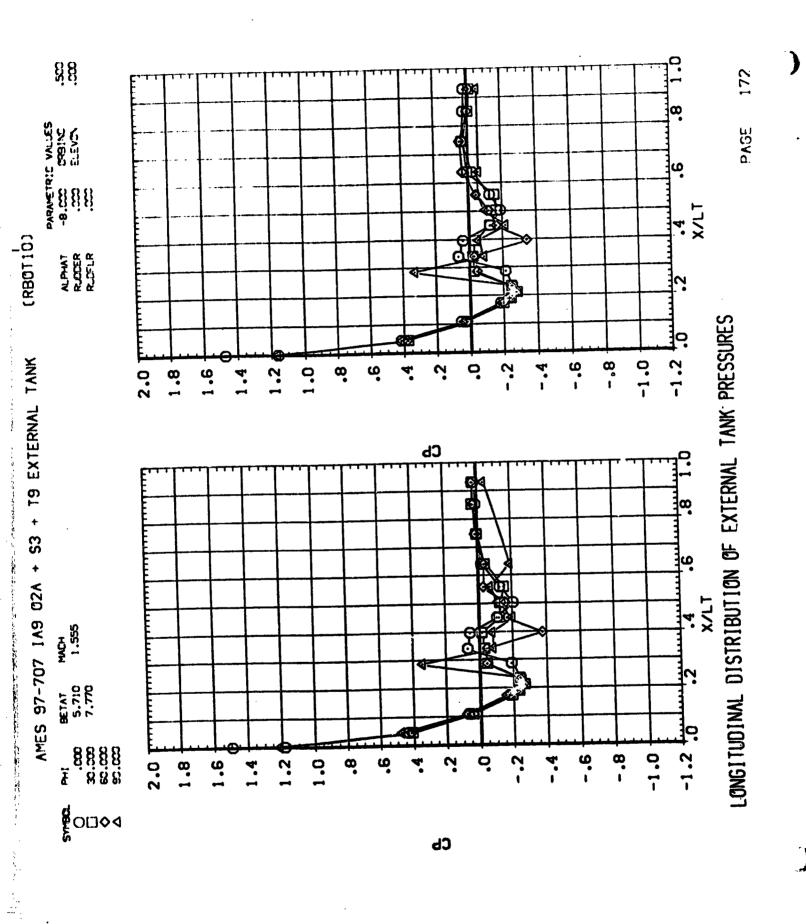


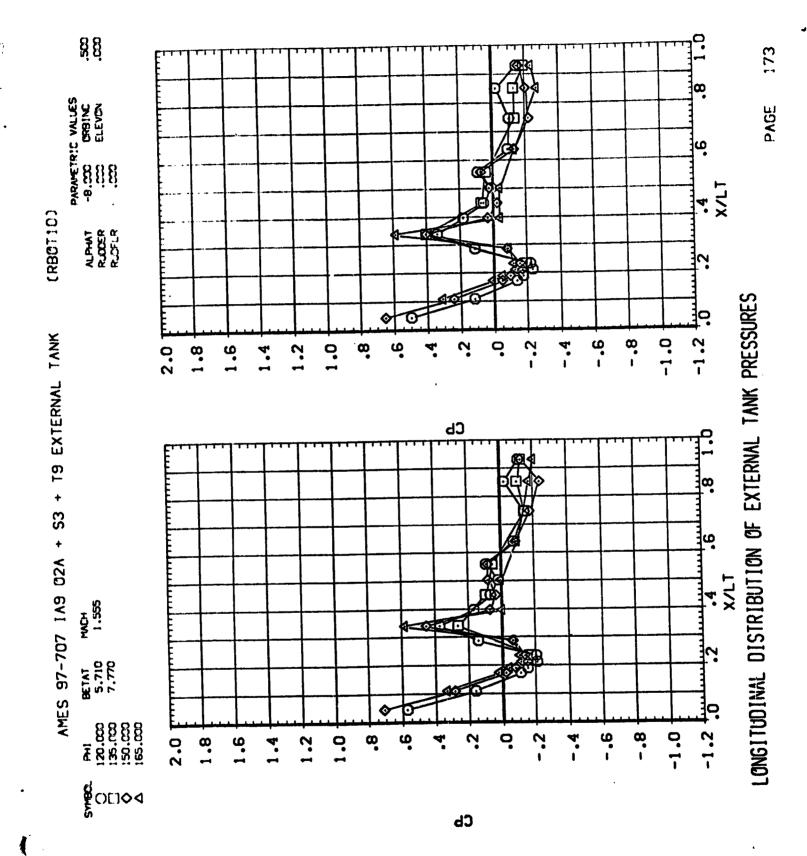


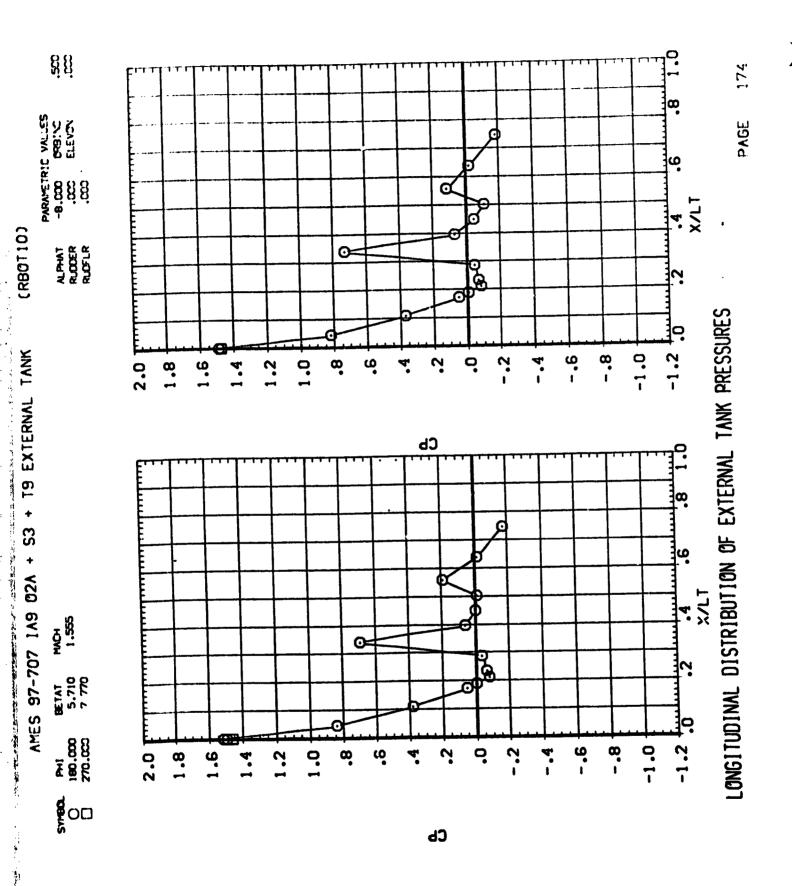
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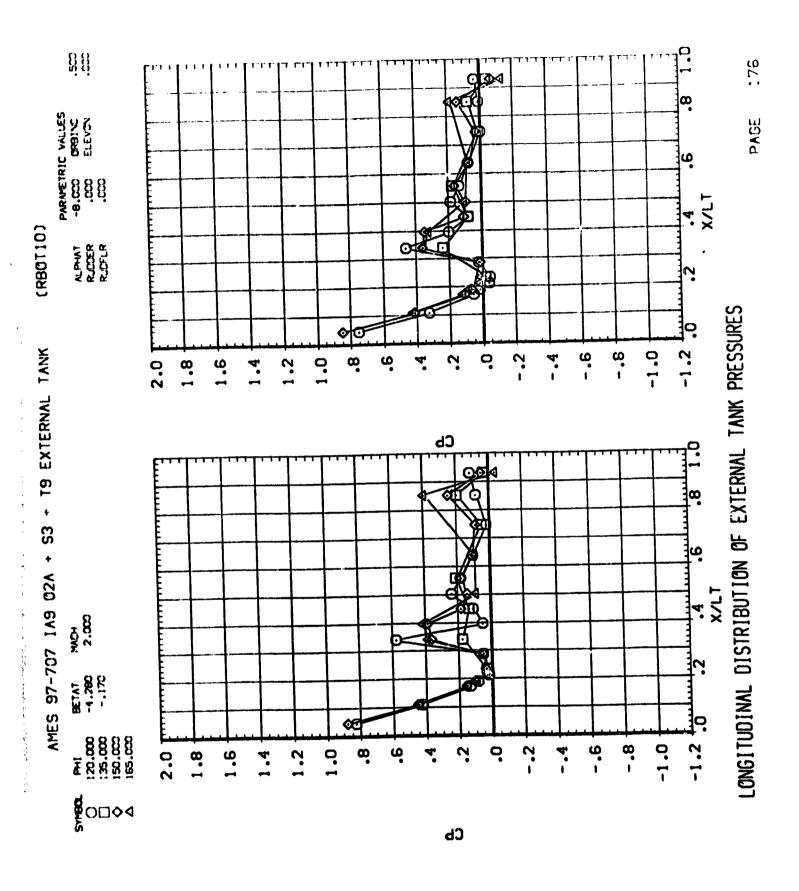
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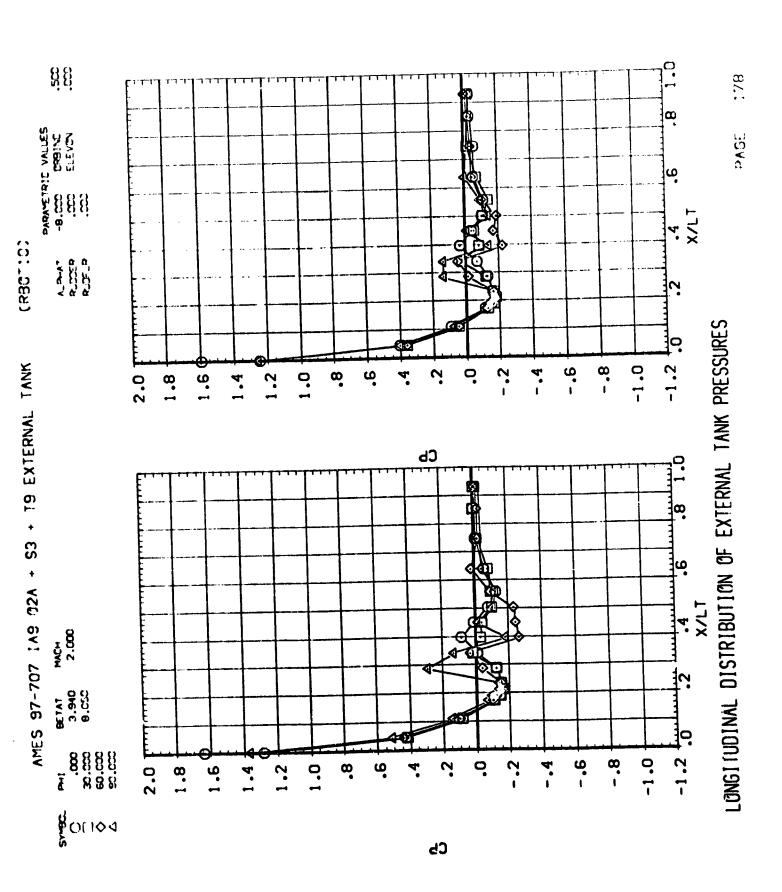




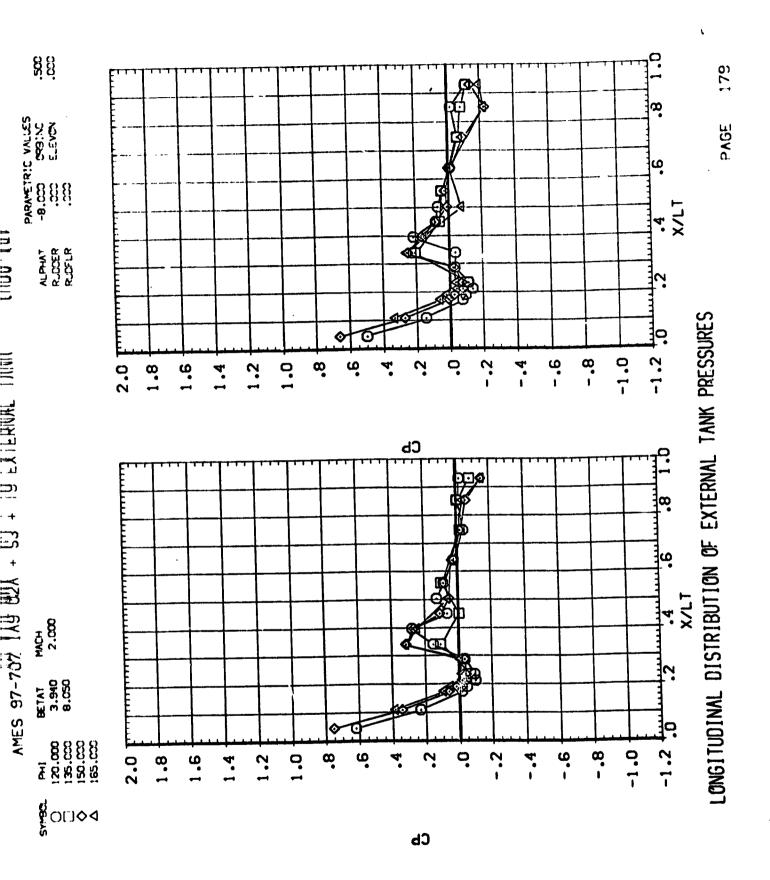
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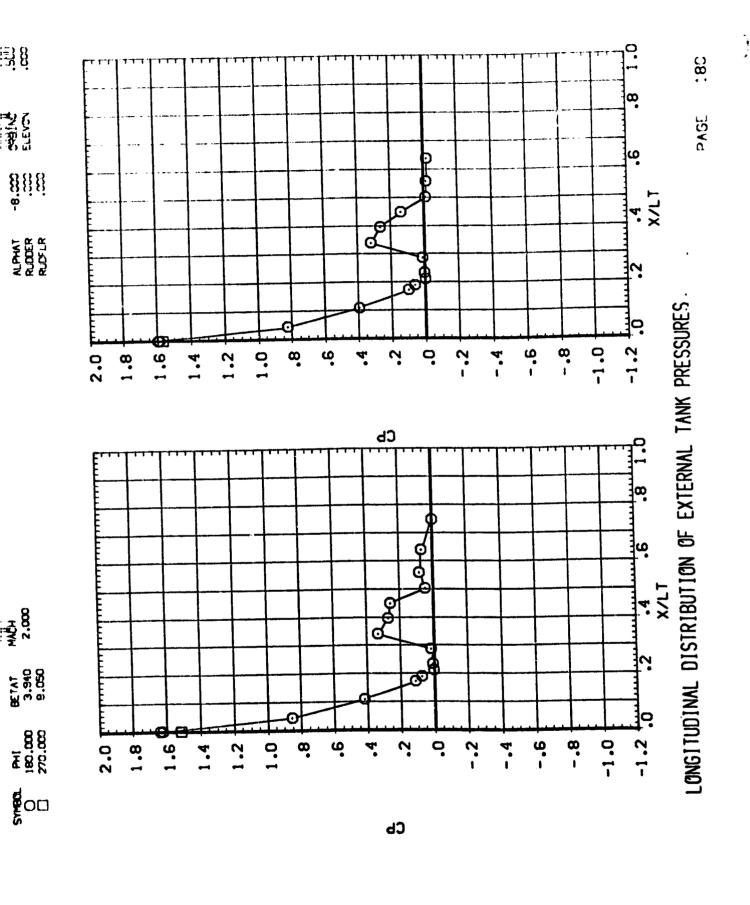
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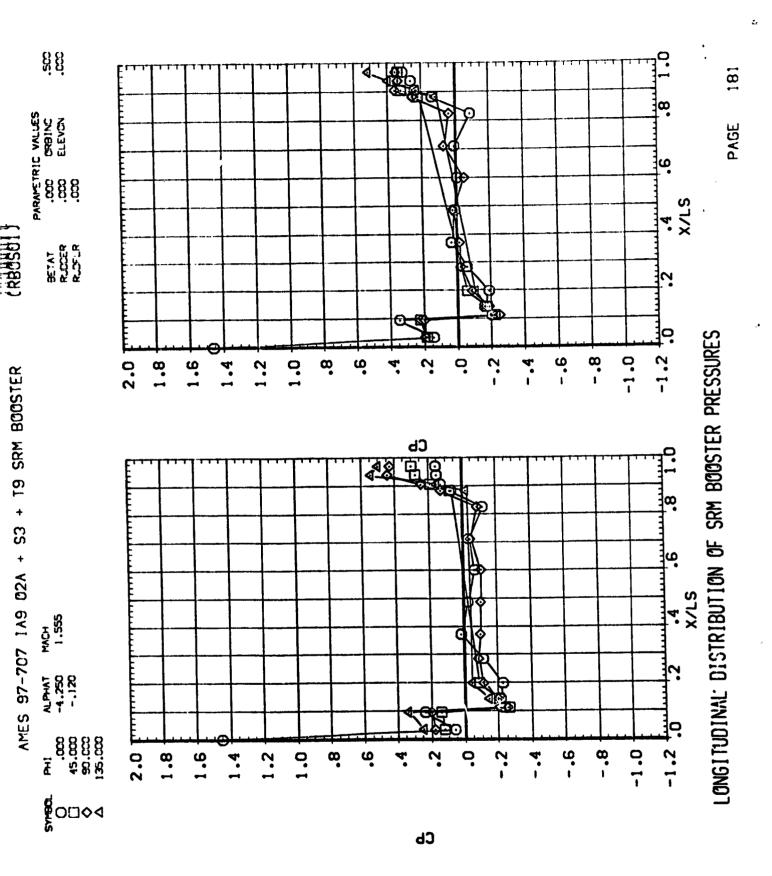


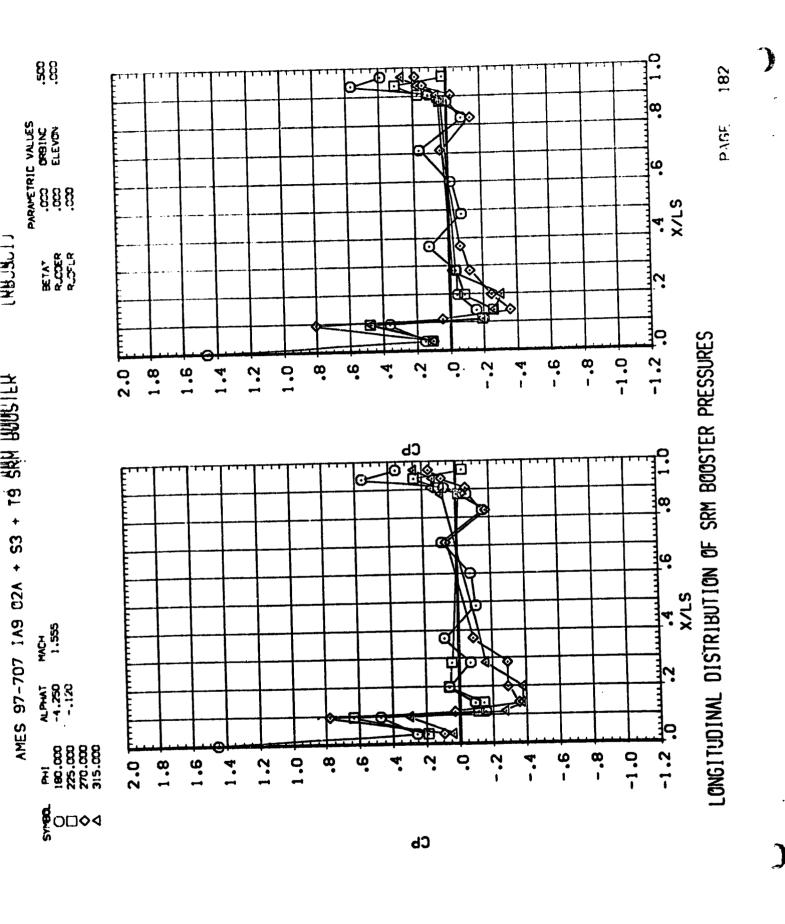
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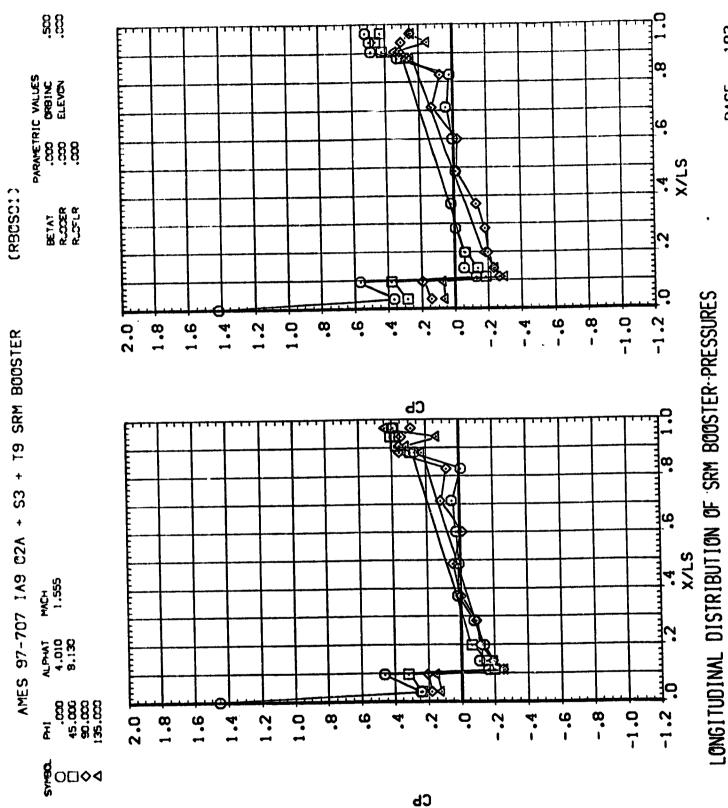


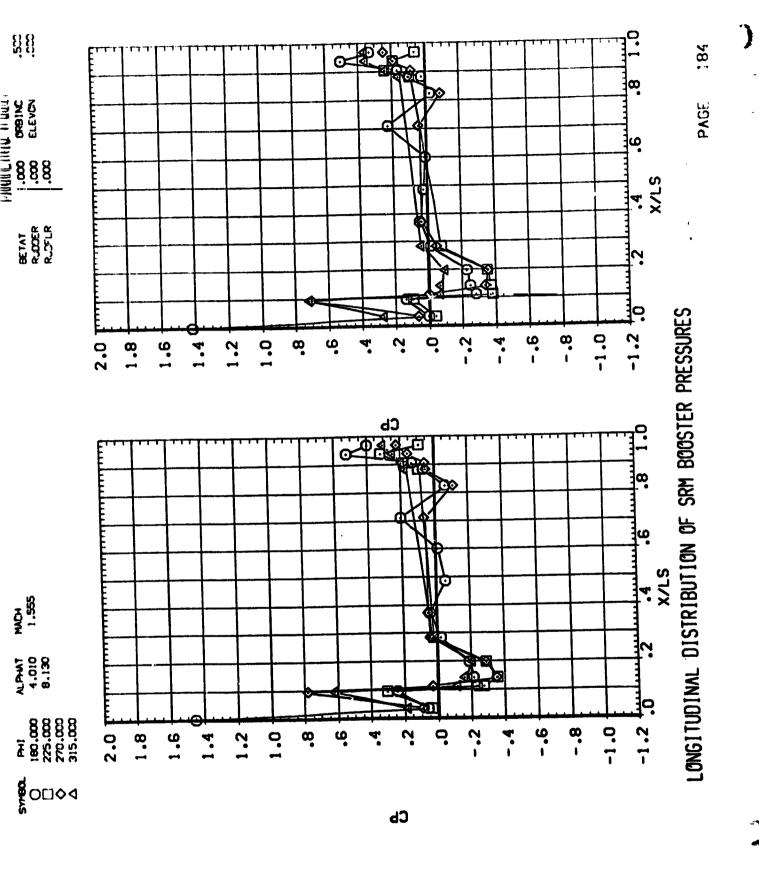
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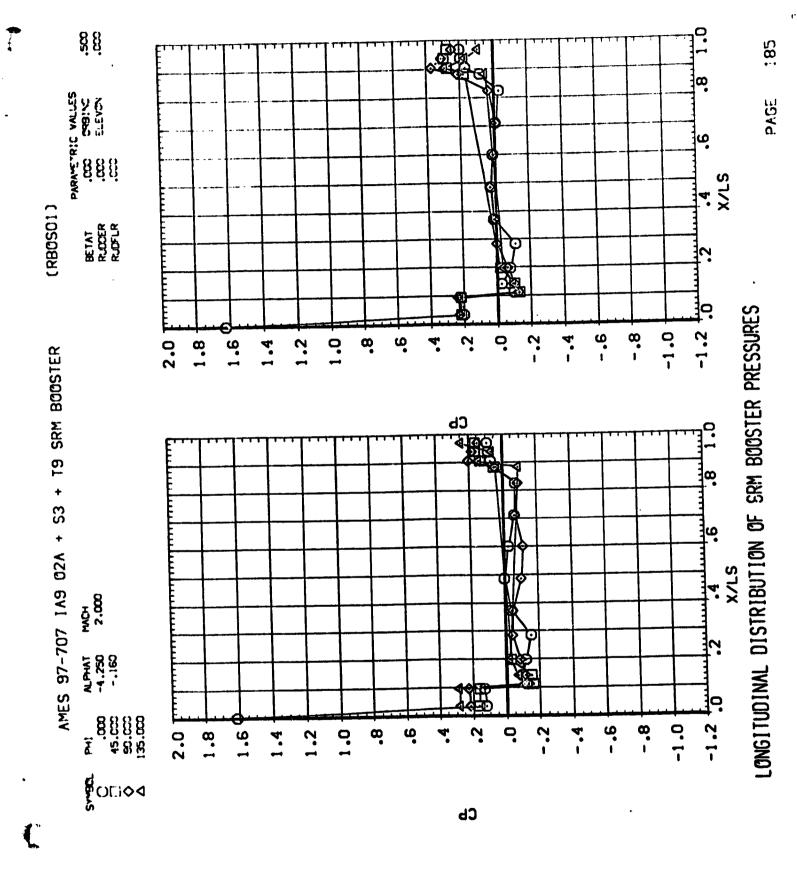


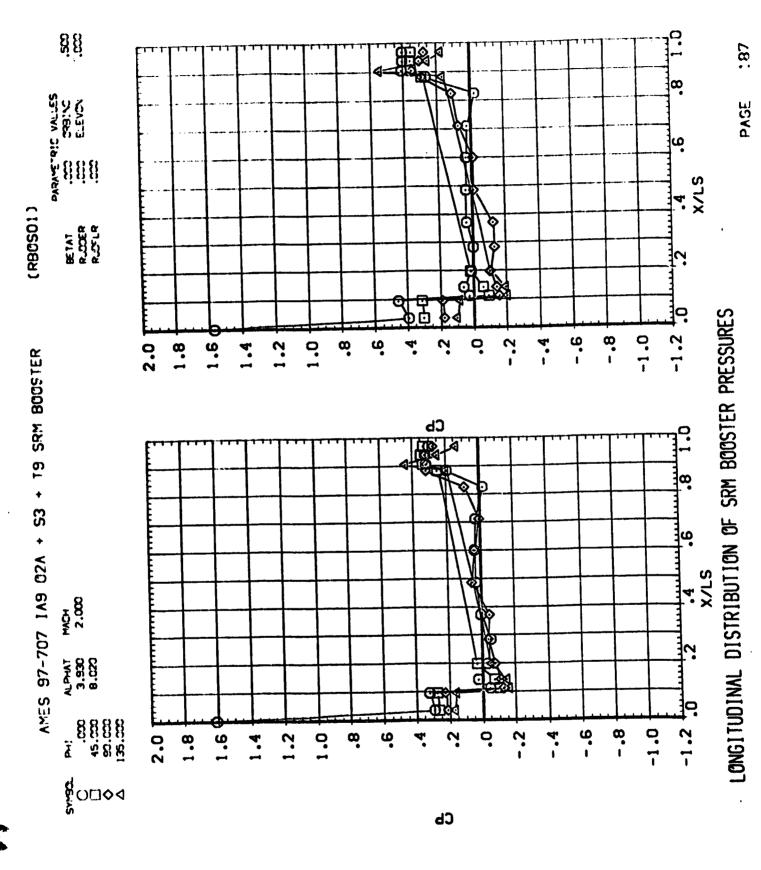
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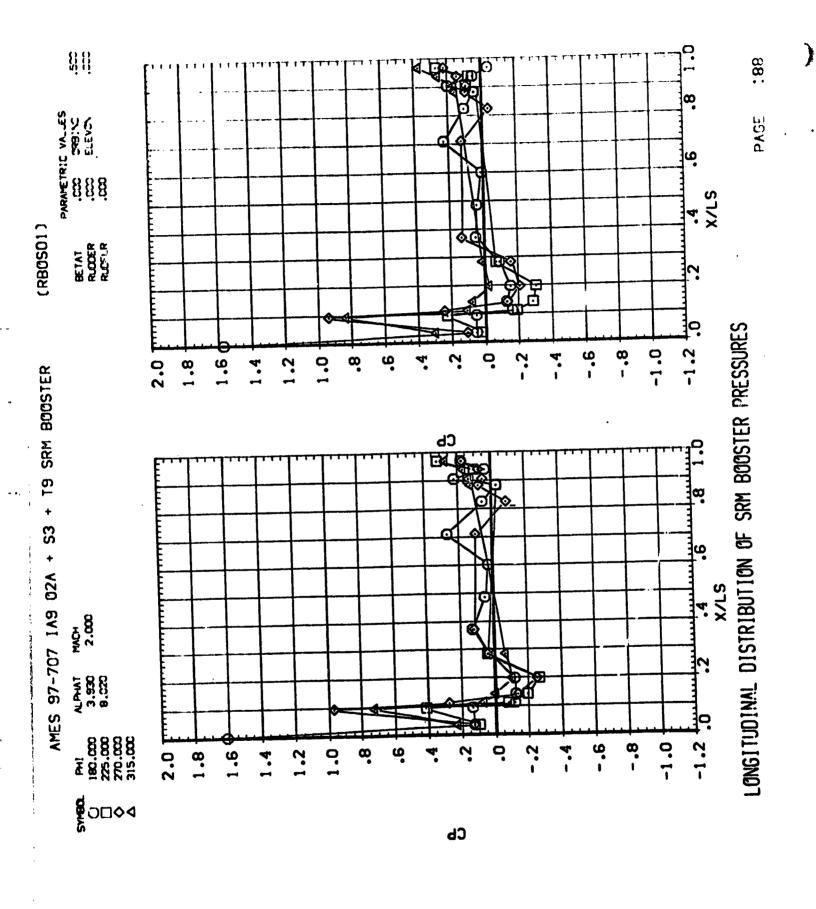


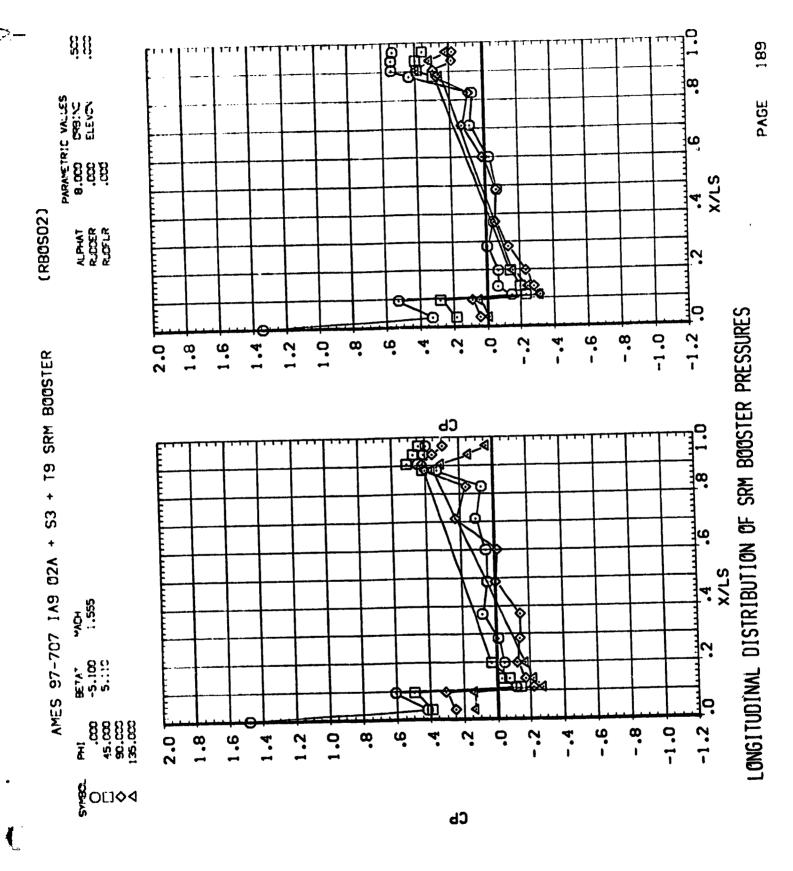


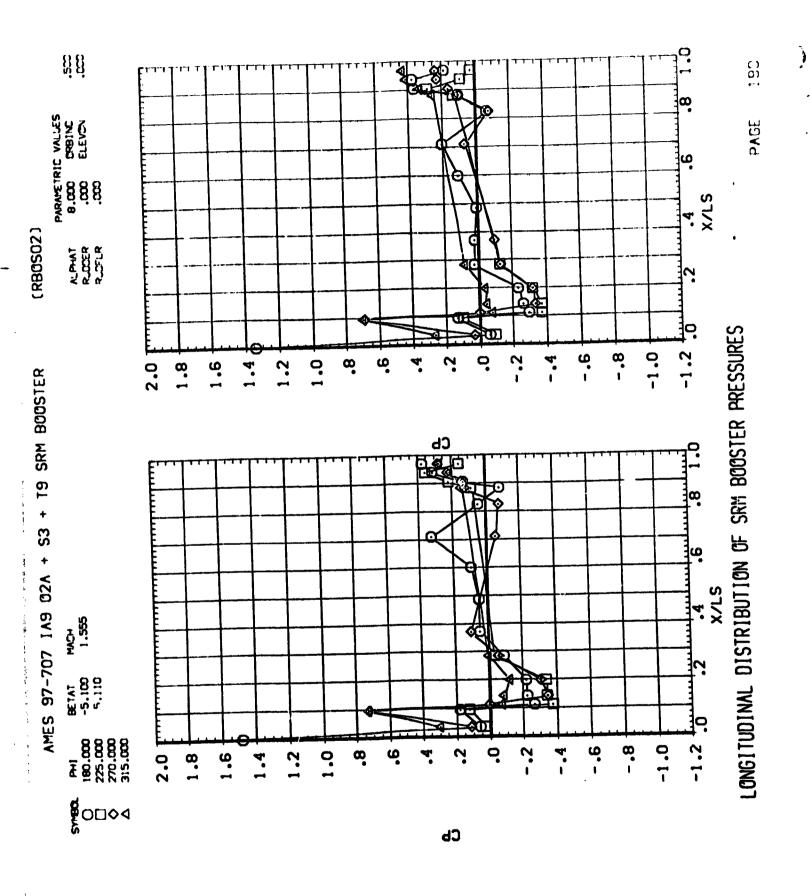
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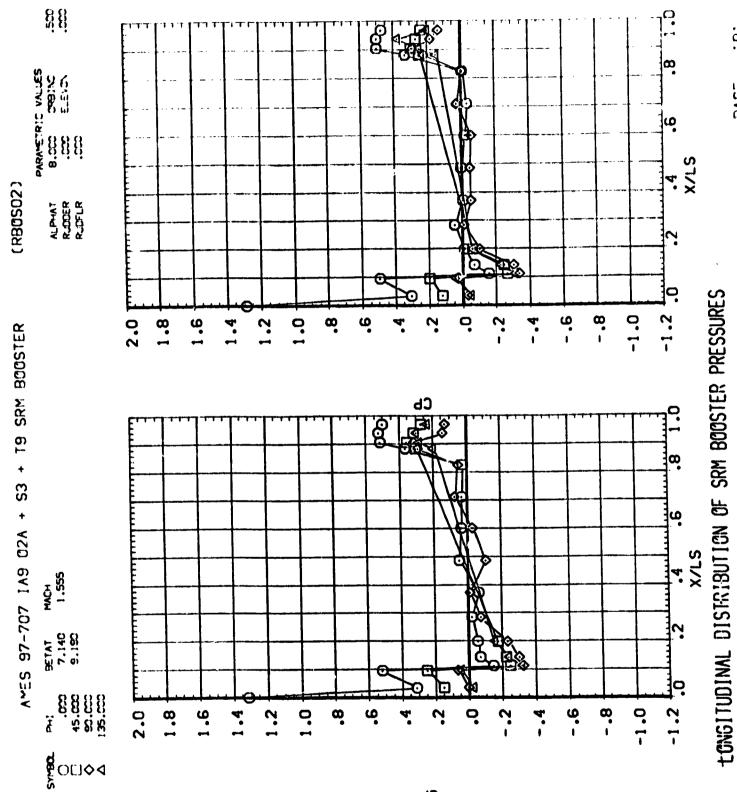






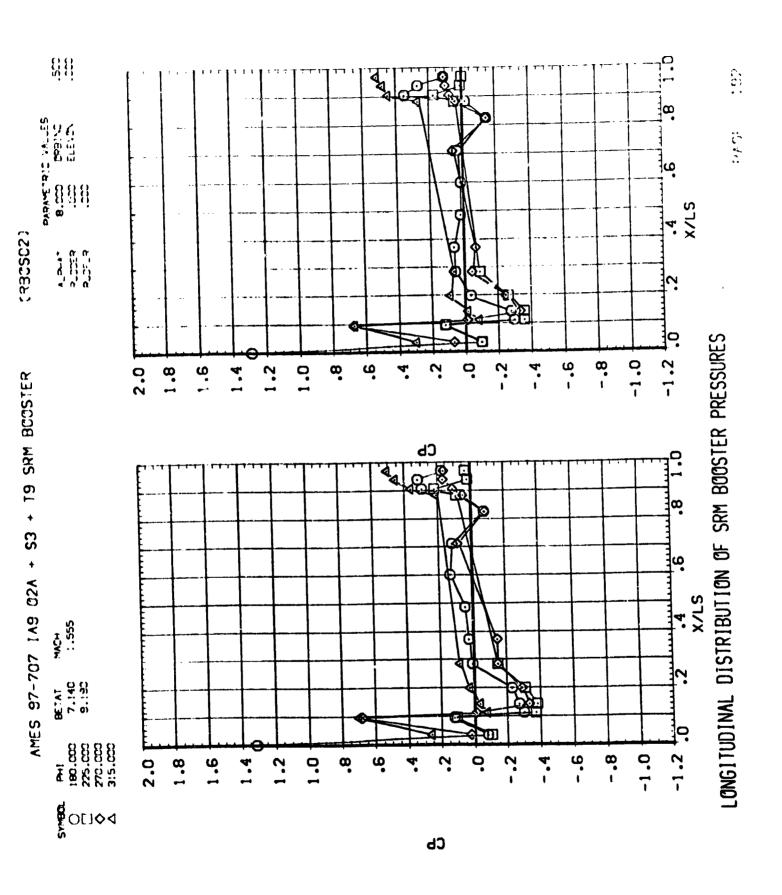




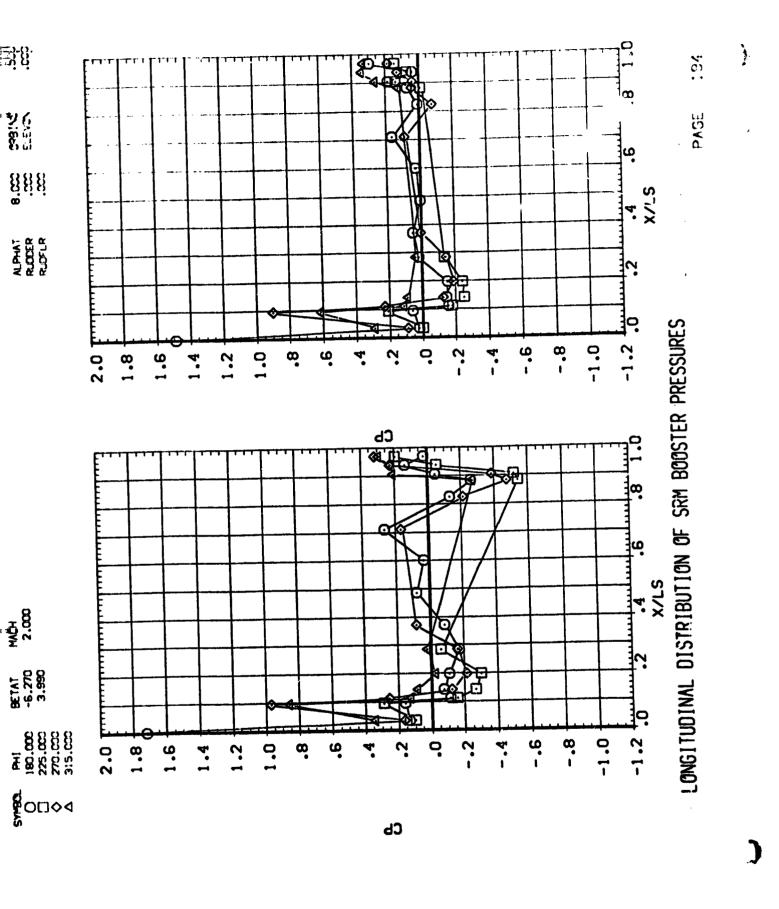


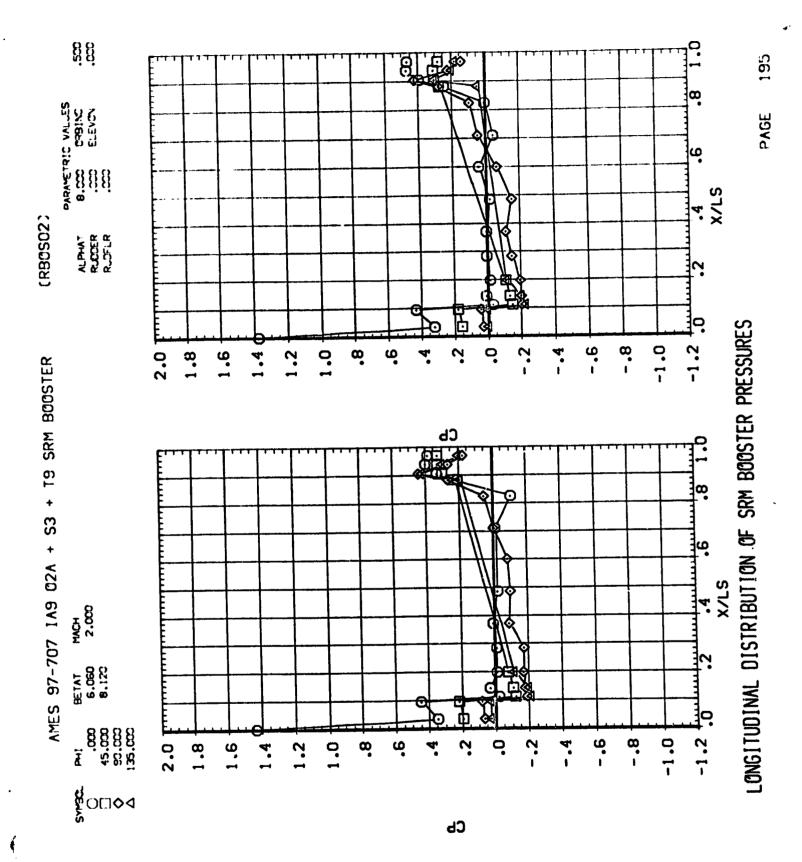
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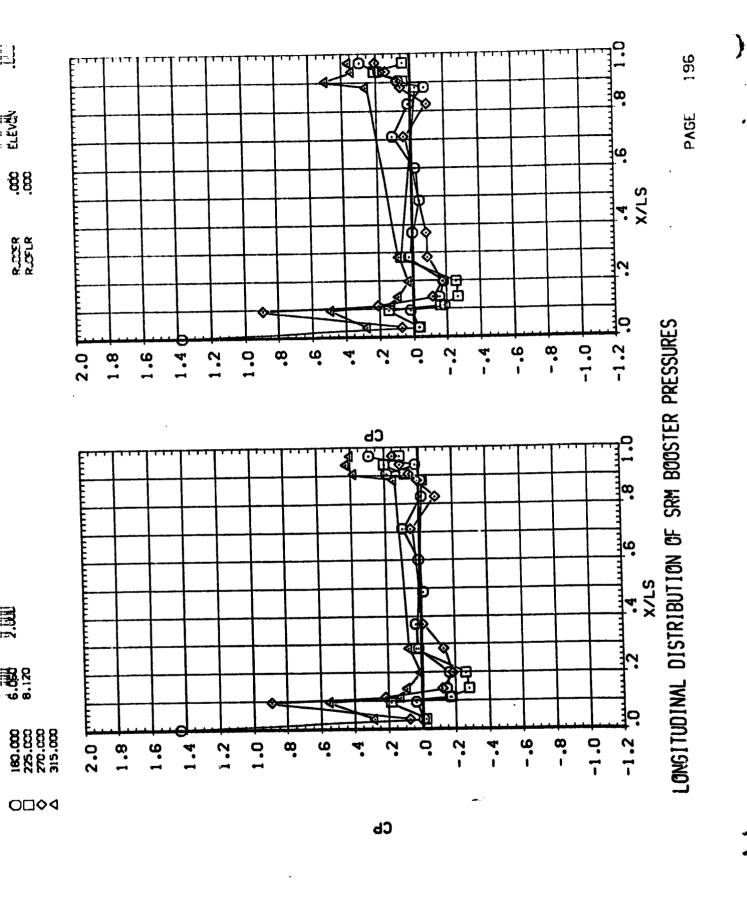
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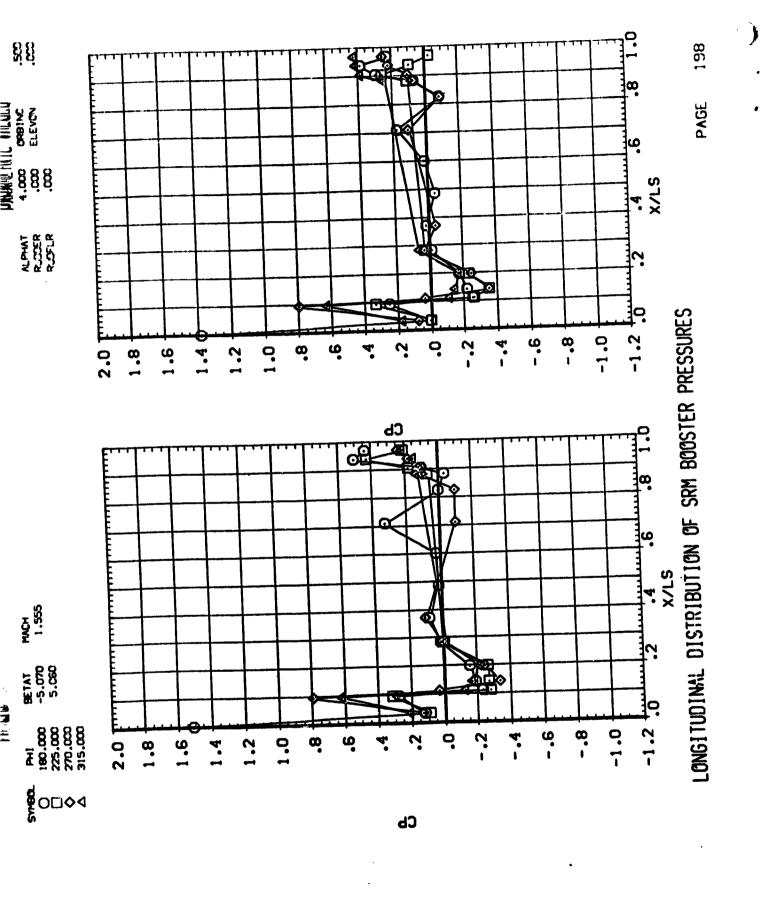




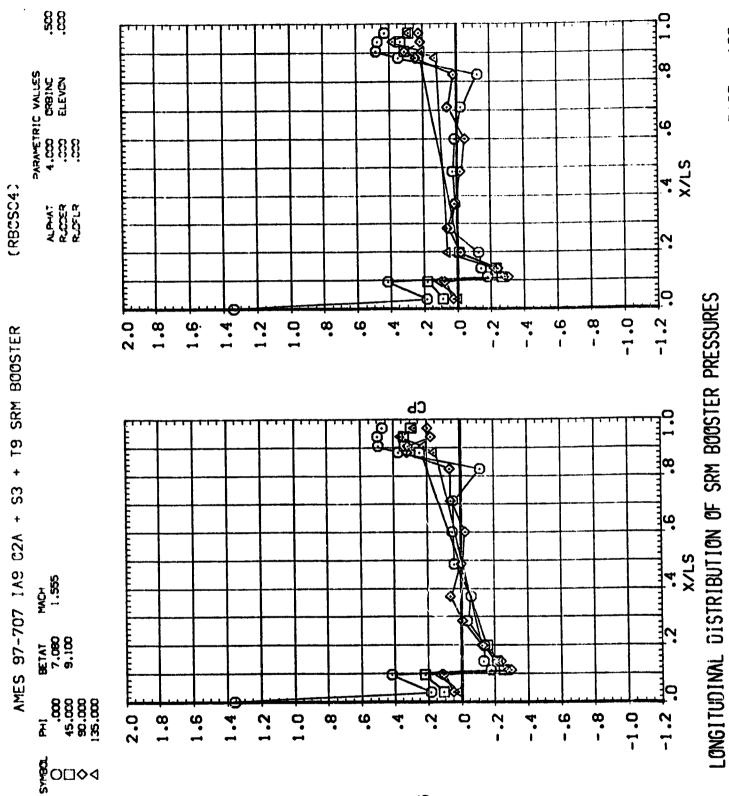


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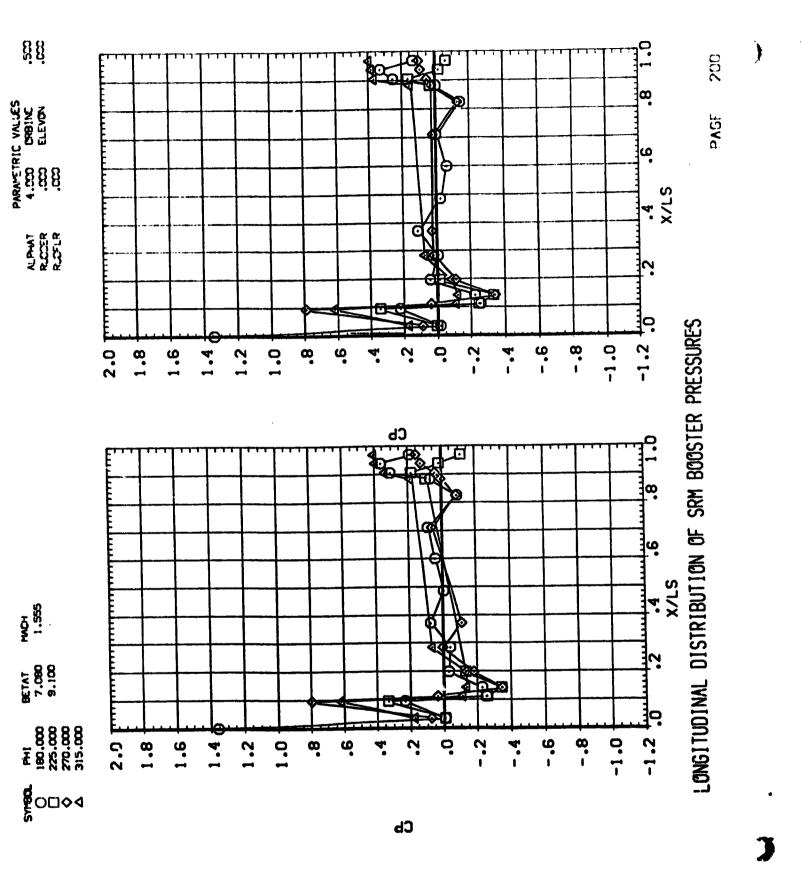
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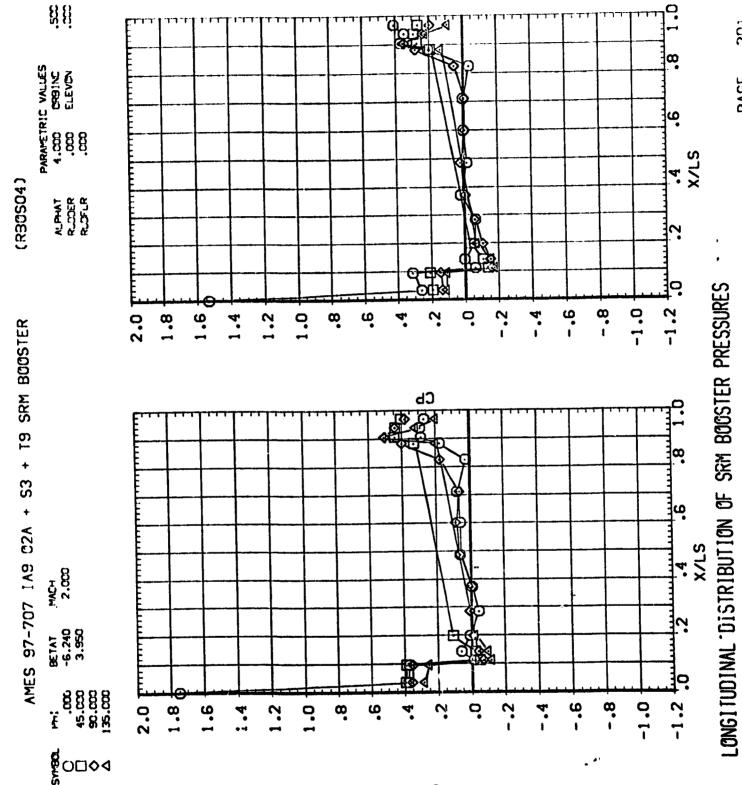


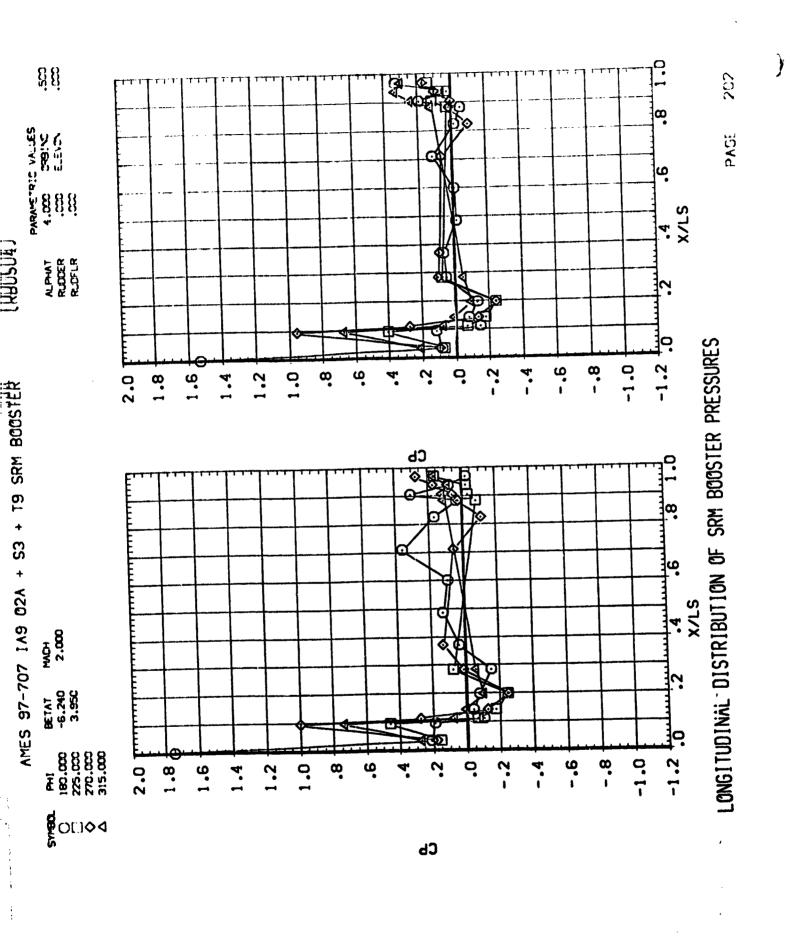
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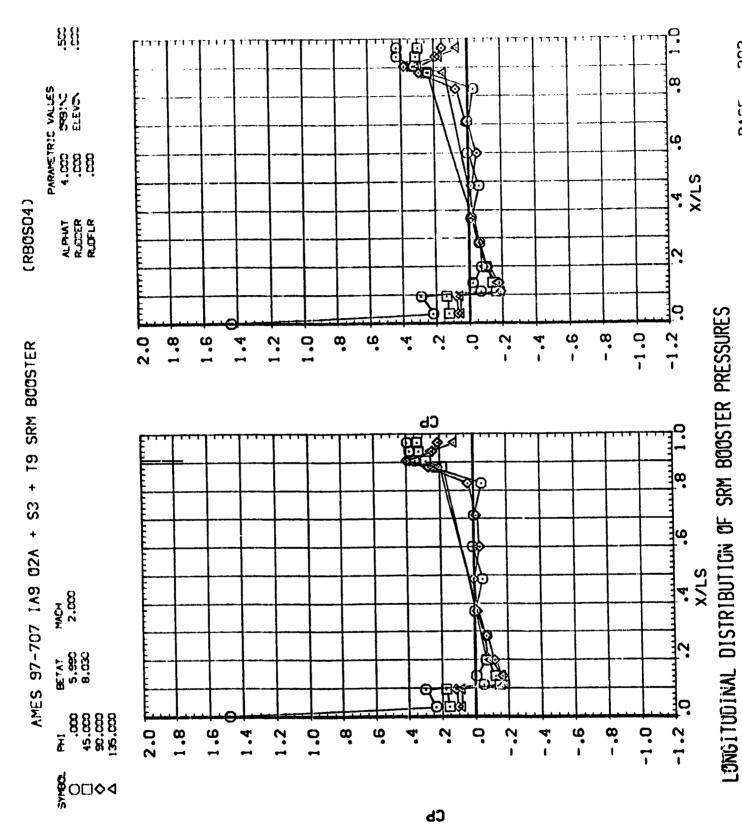
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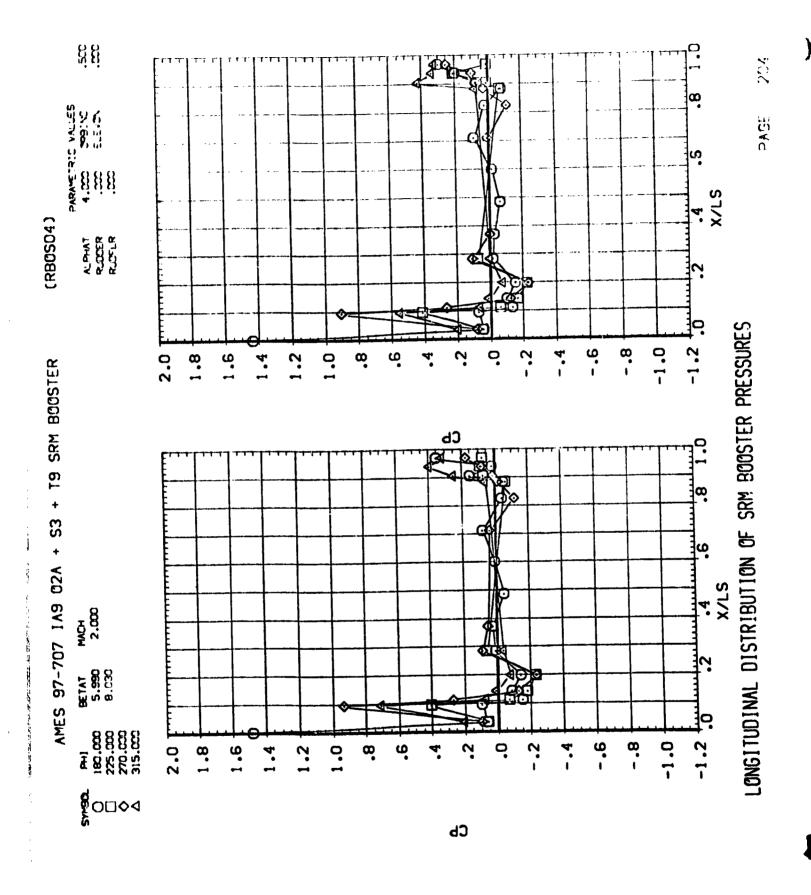
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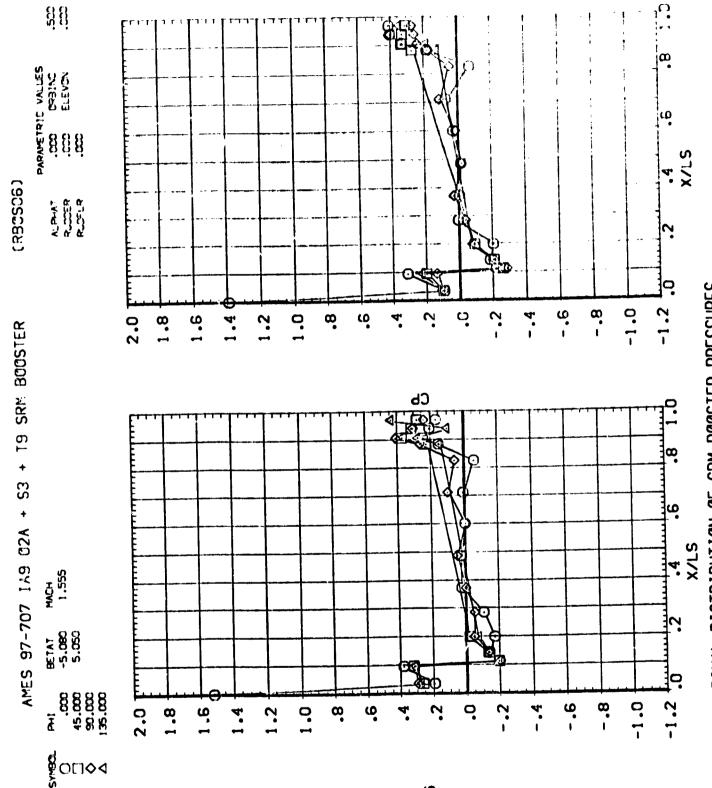












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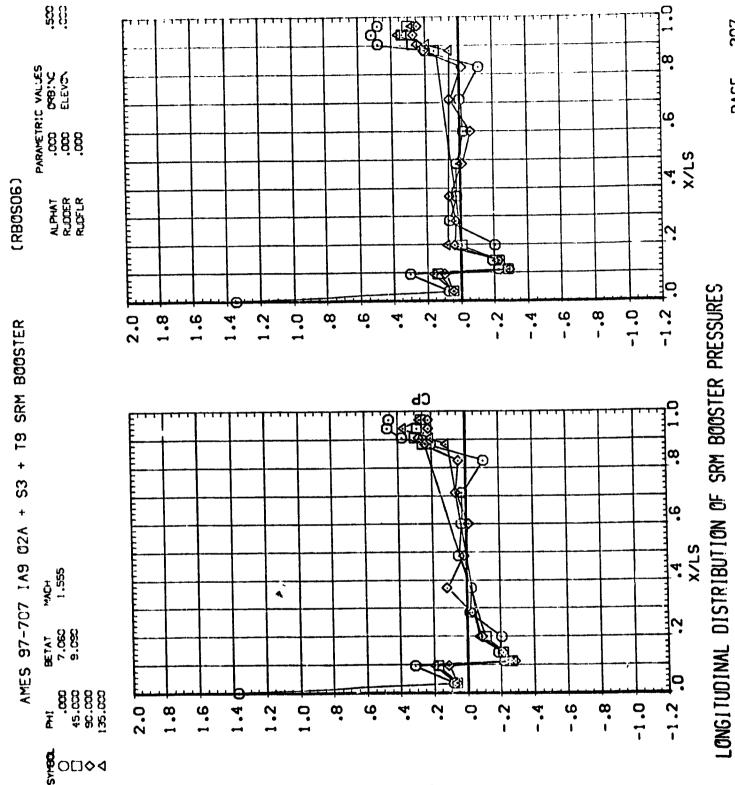
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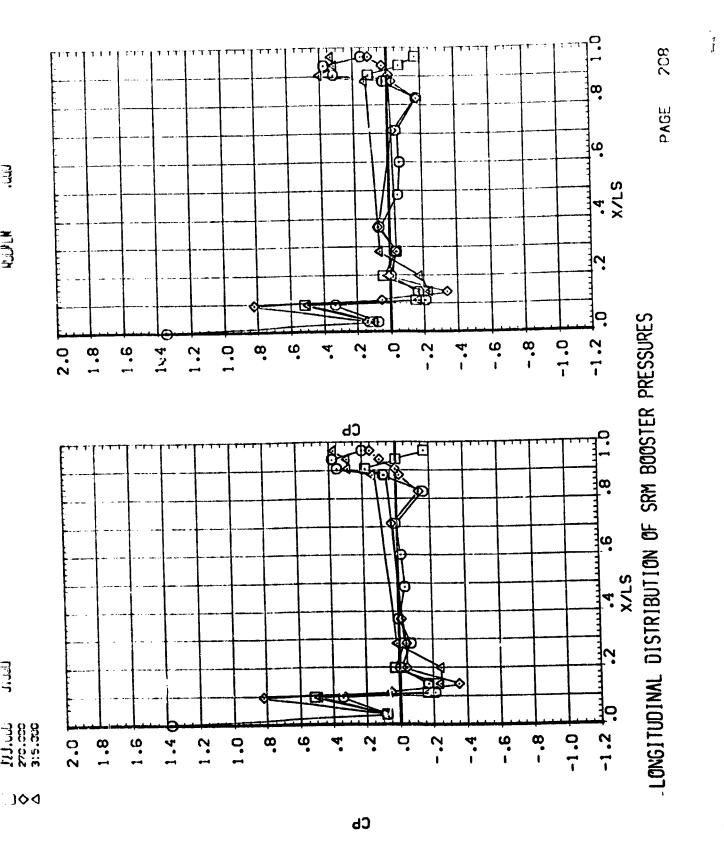
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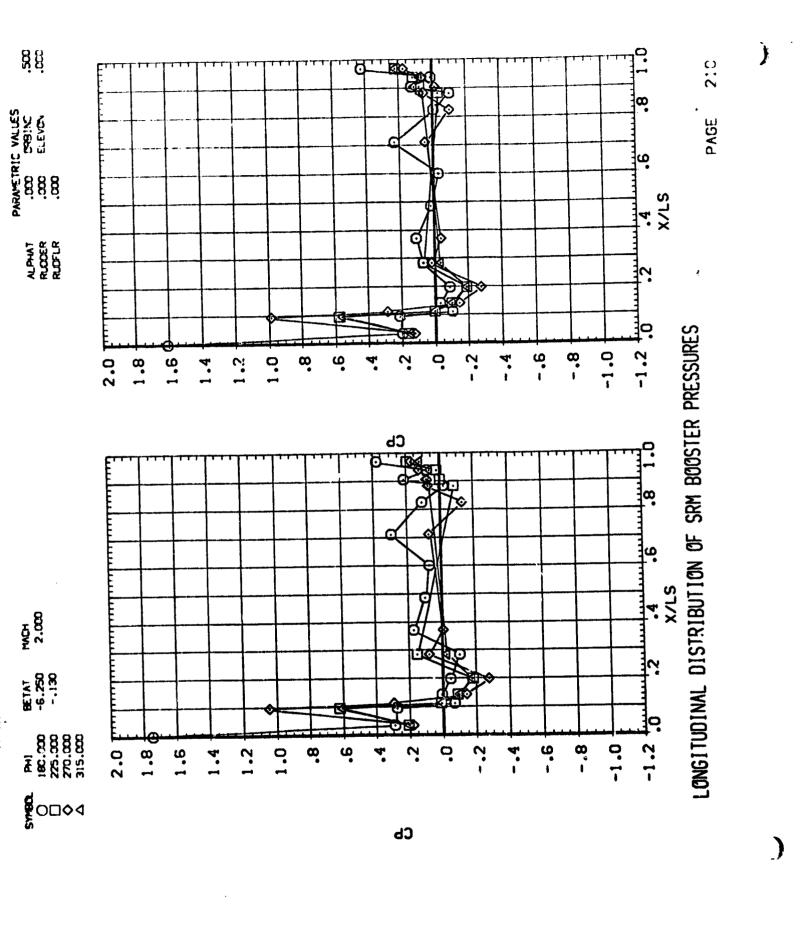
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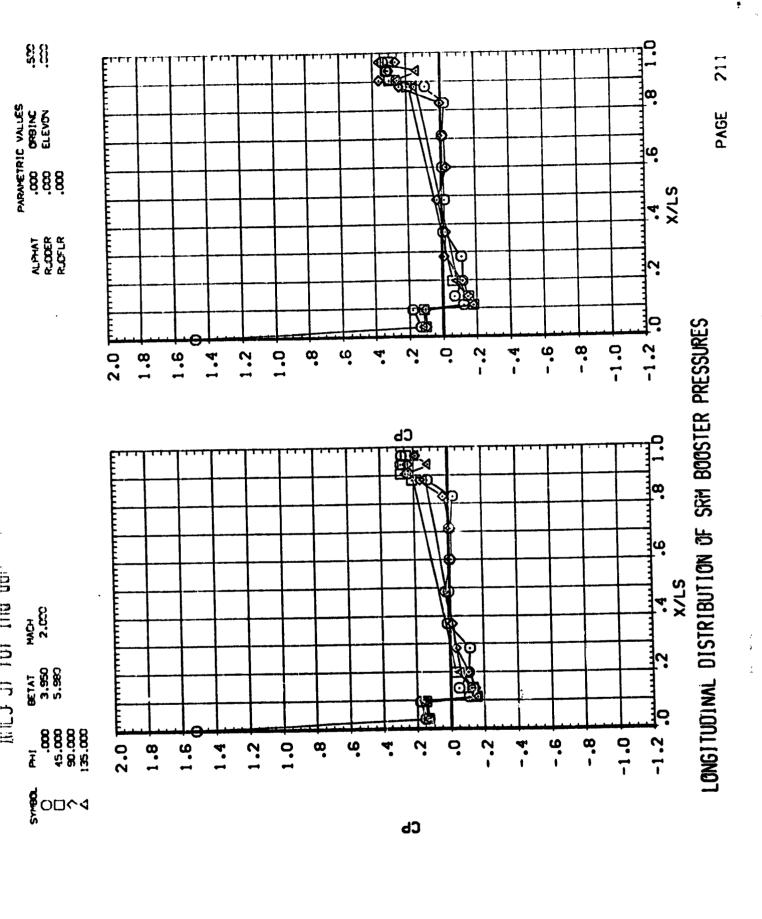
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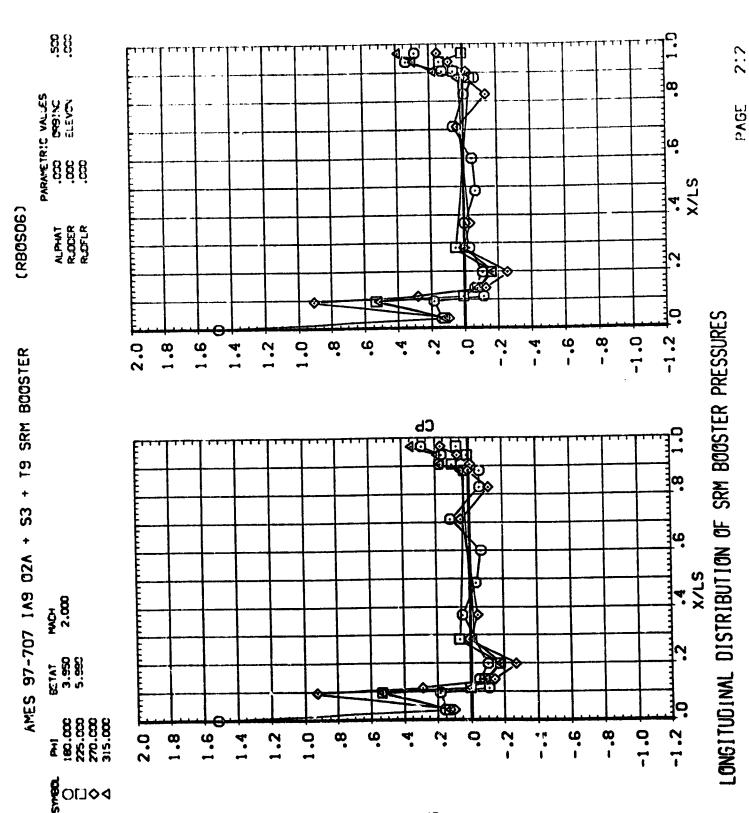




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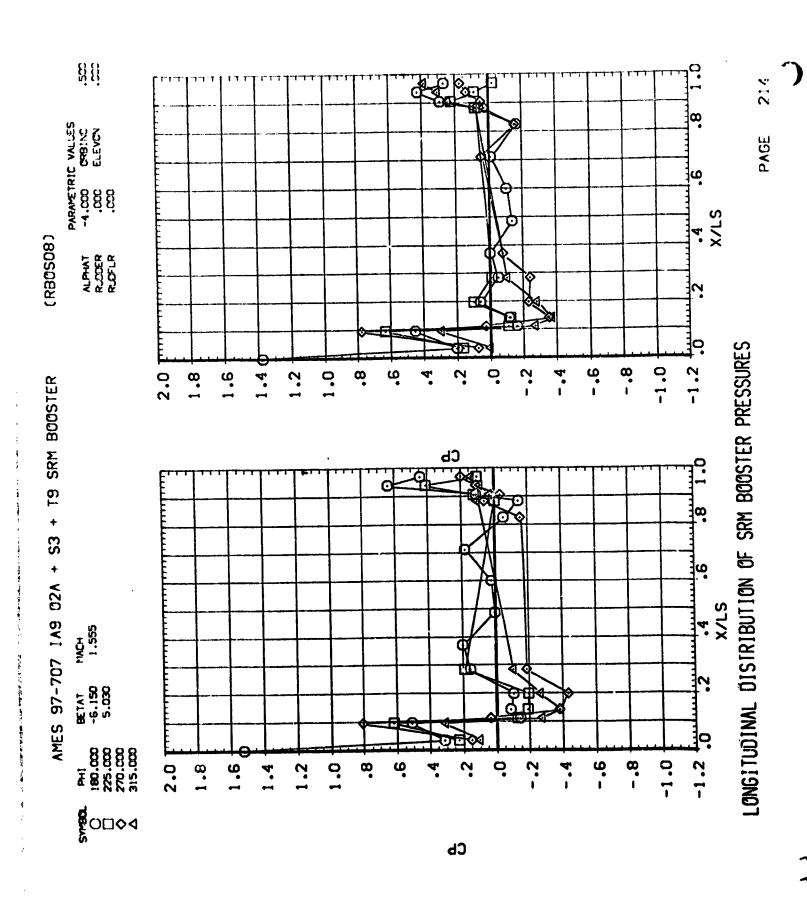
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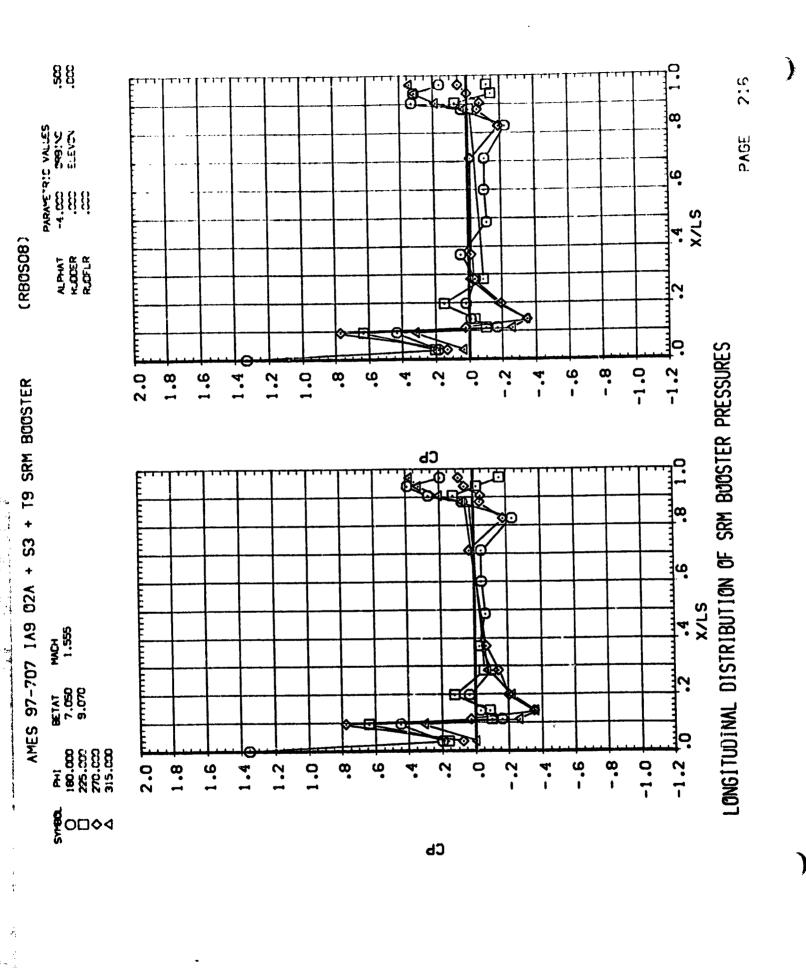
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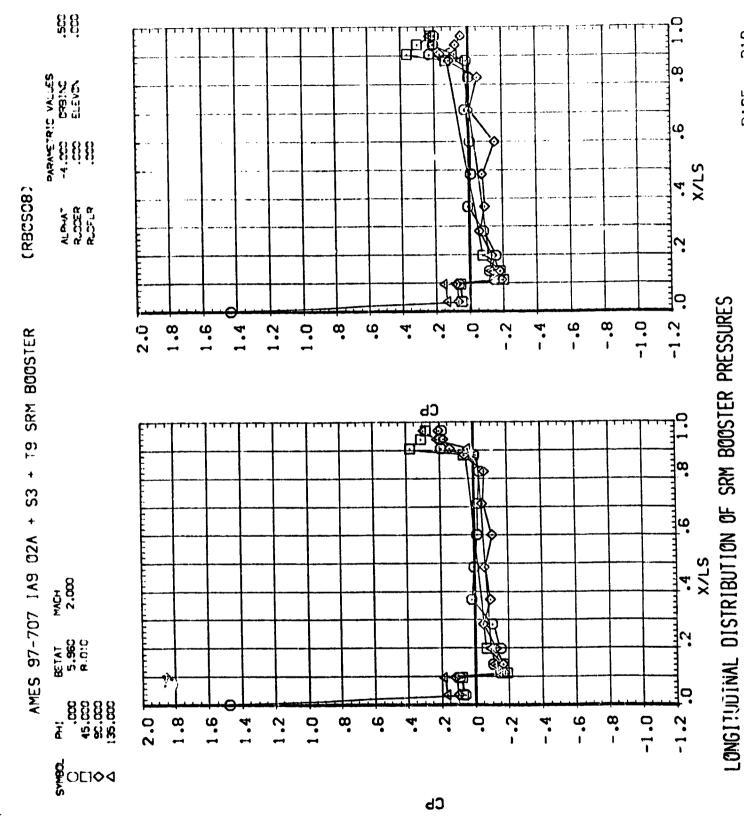
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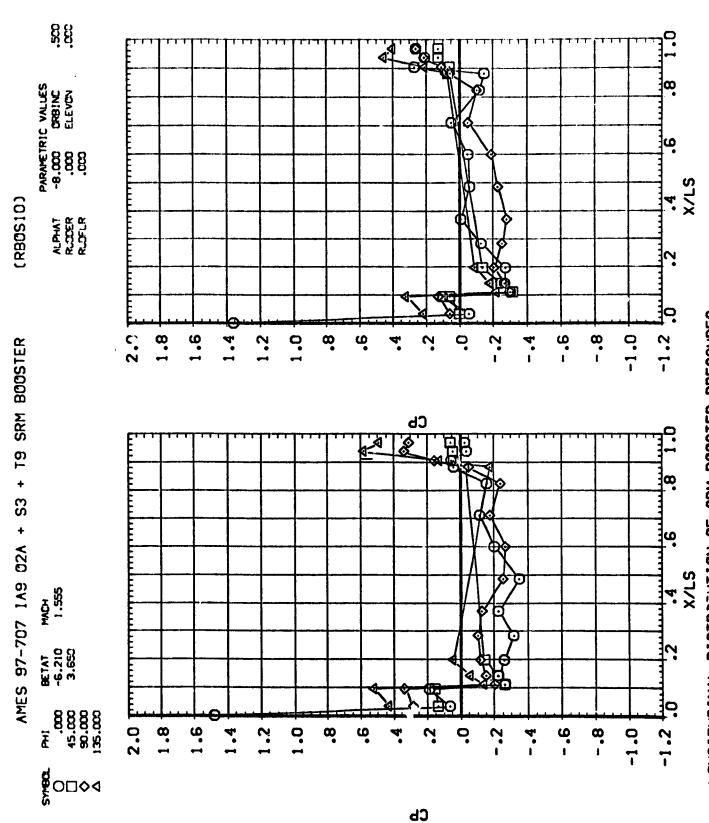
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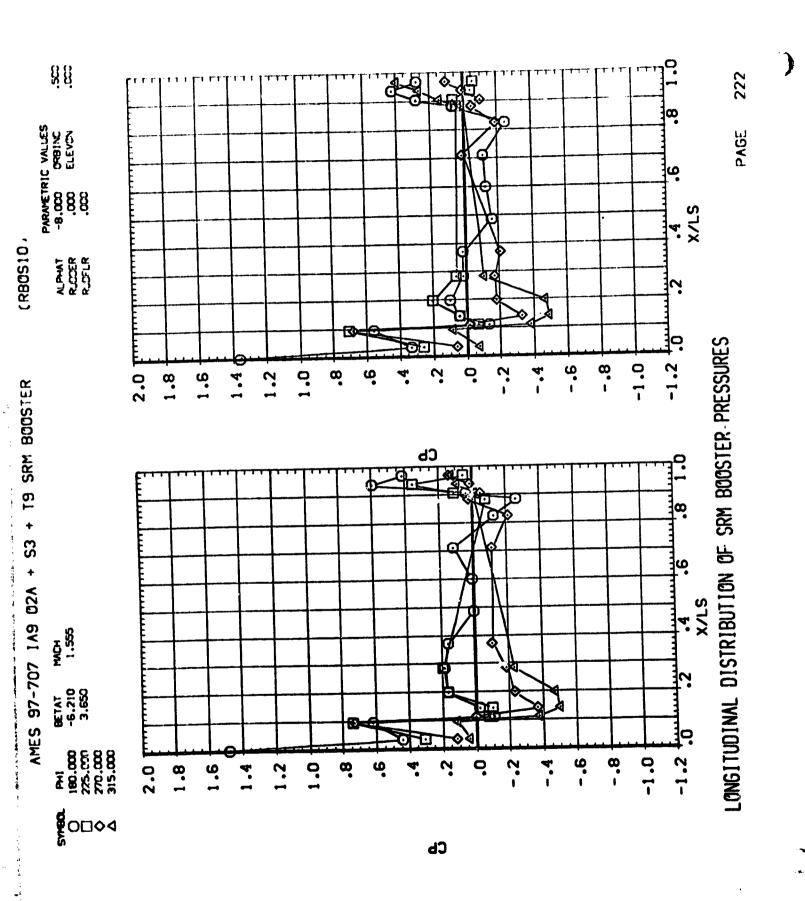
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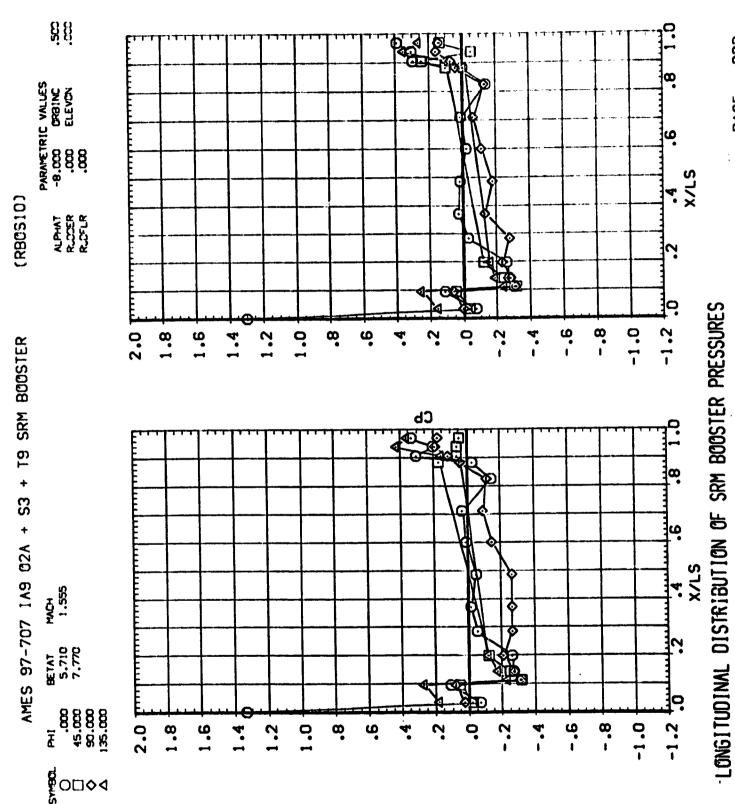
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LONGITUDINAL DISTRIBUTION OF SRM BOOSTER PRESSURES

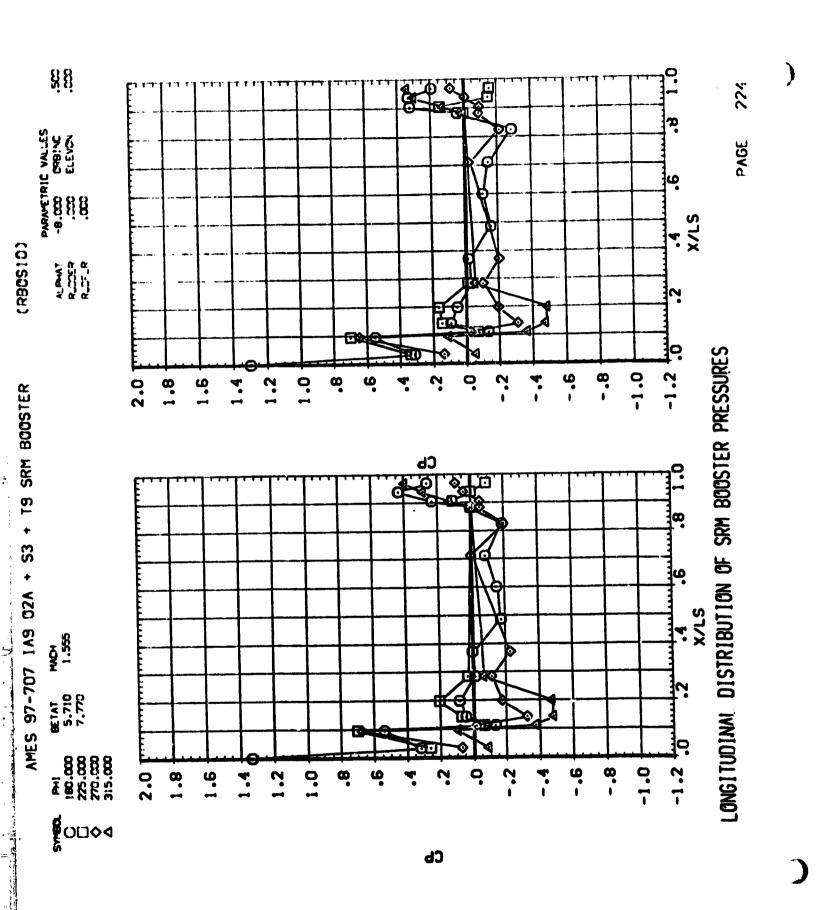


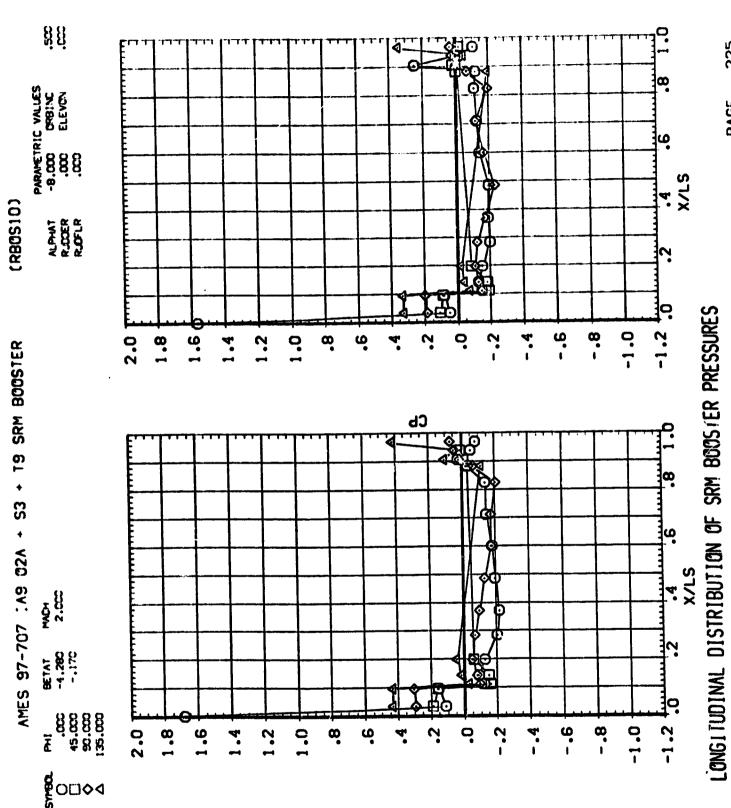


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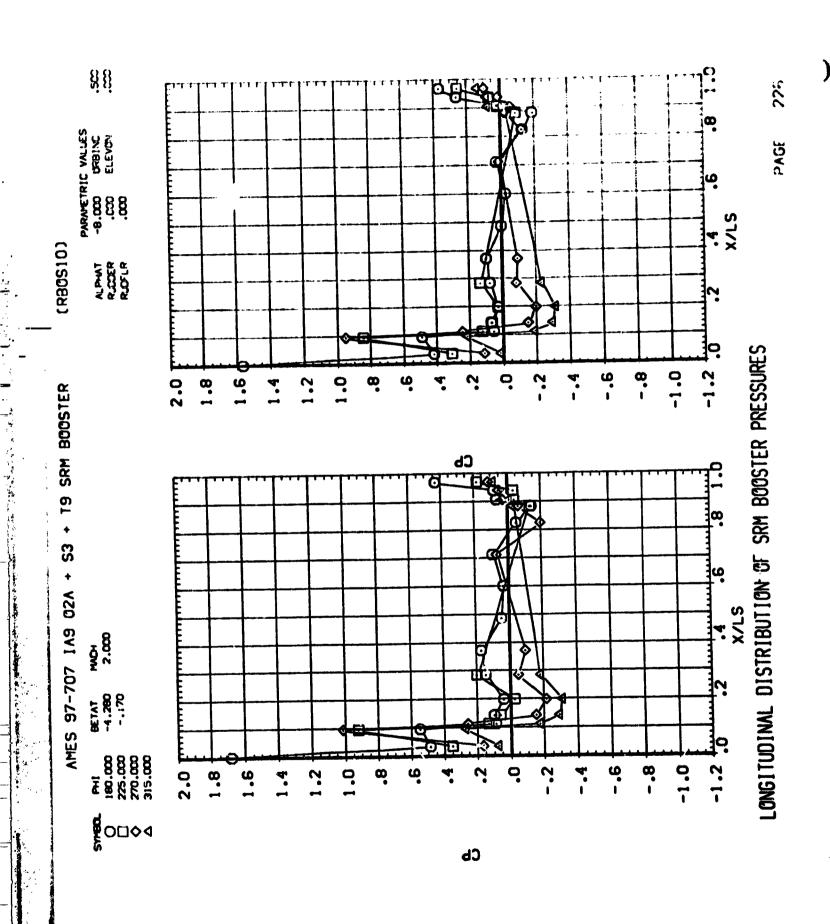


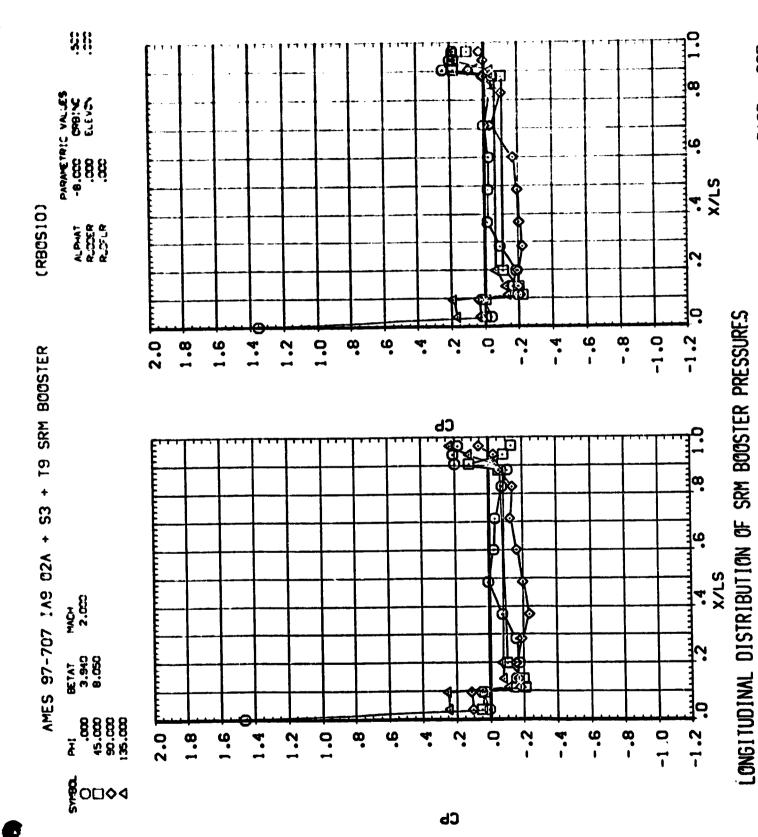


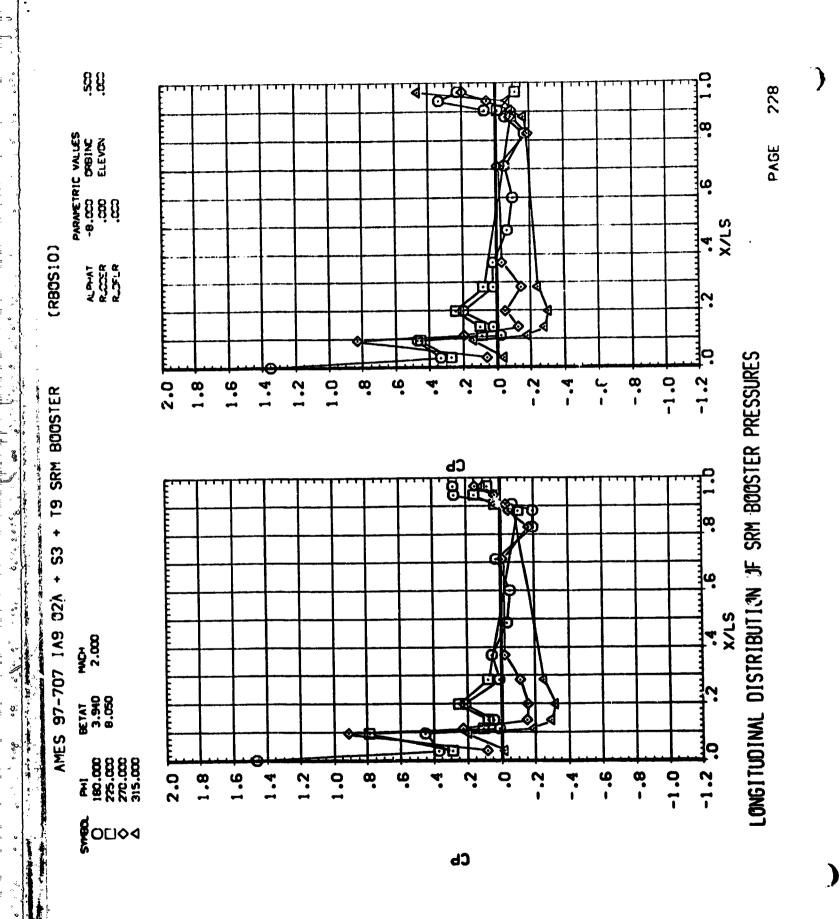
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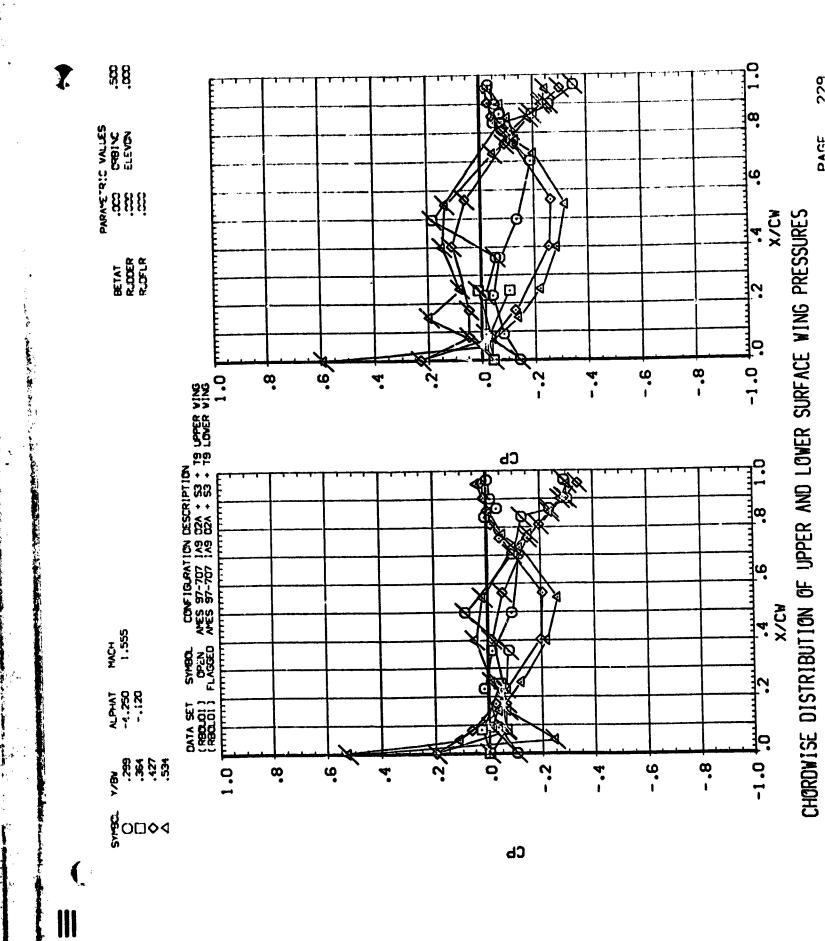
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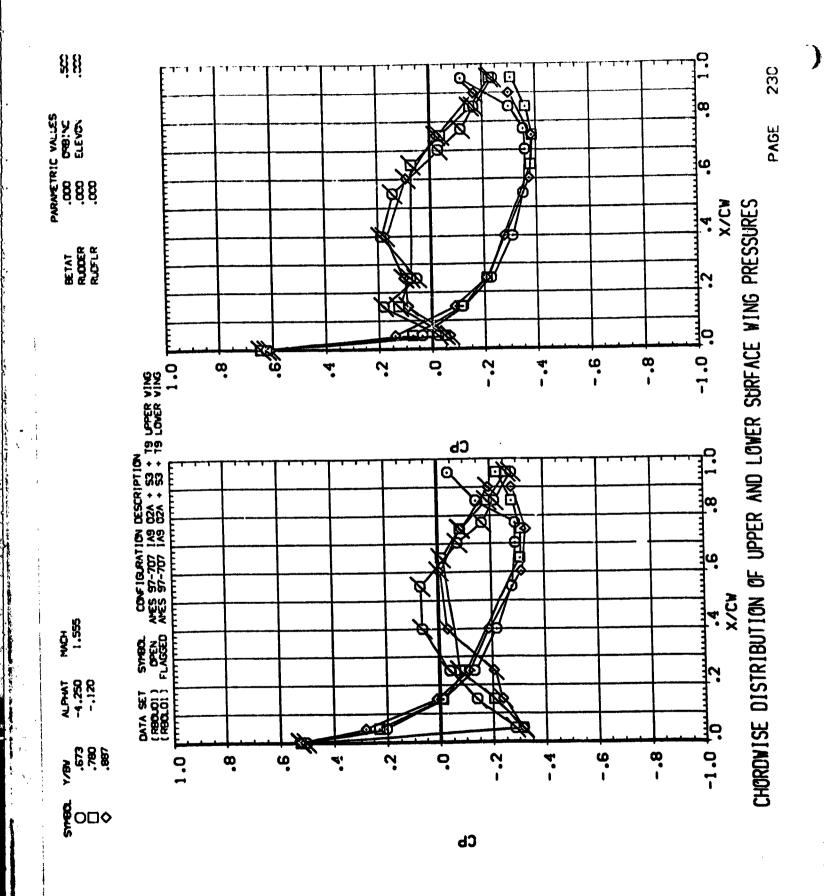


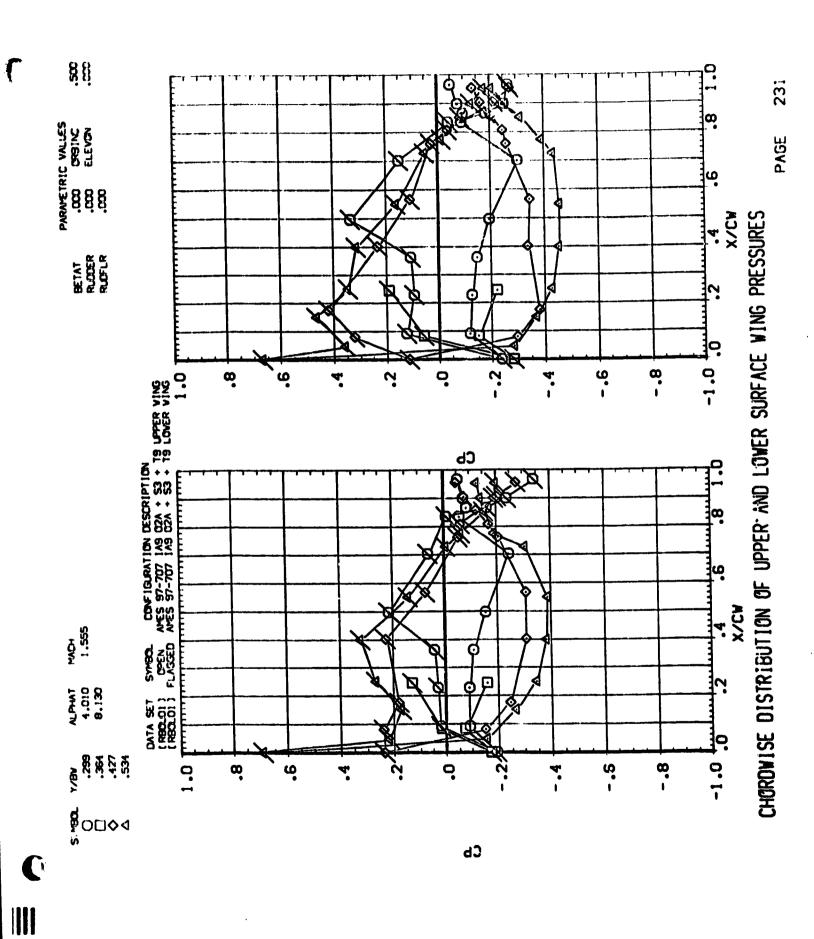


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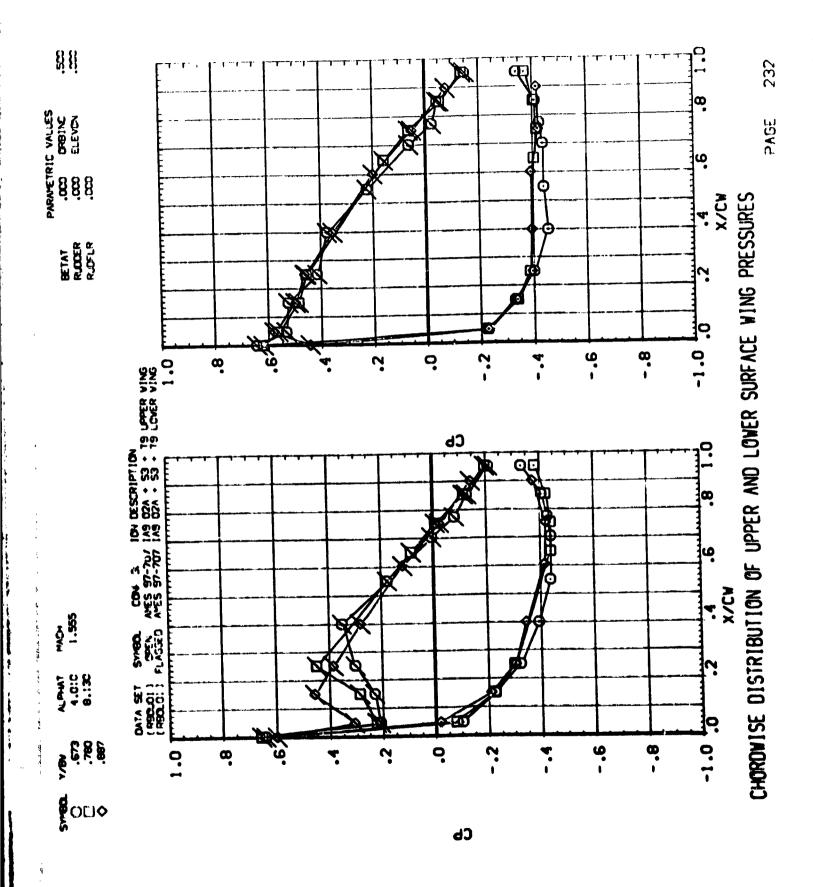
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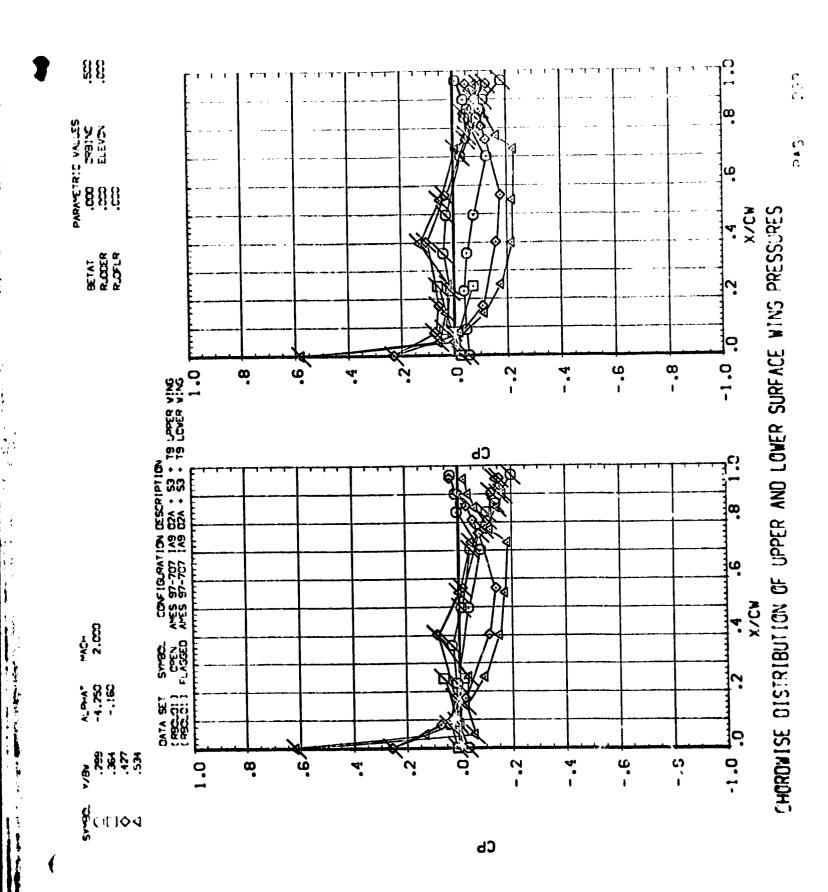


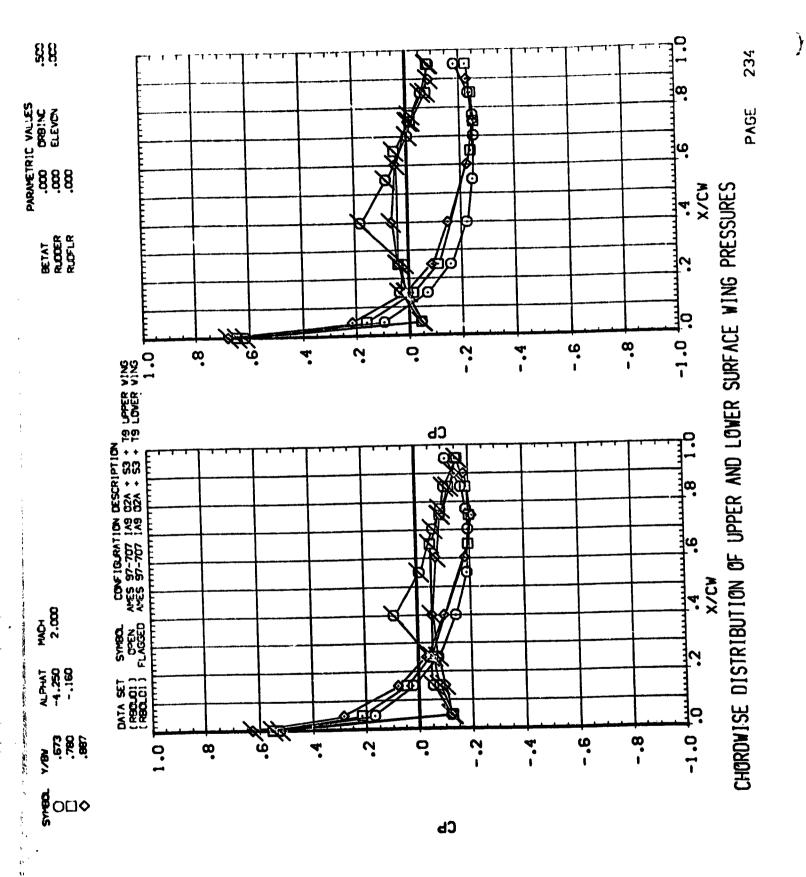


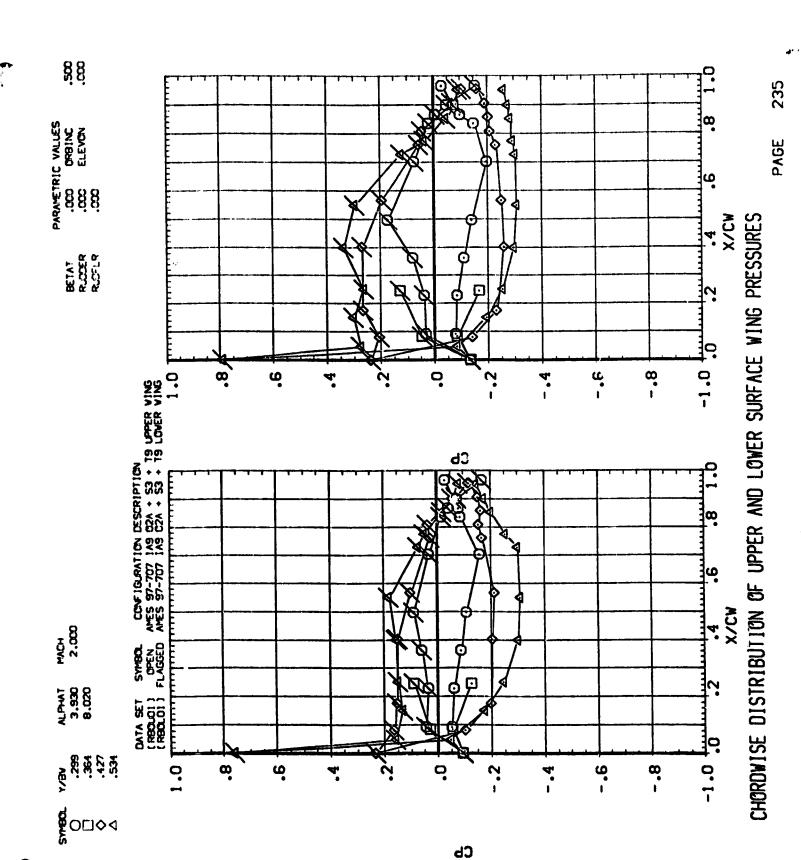
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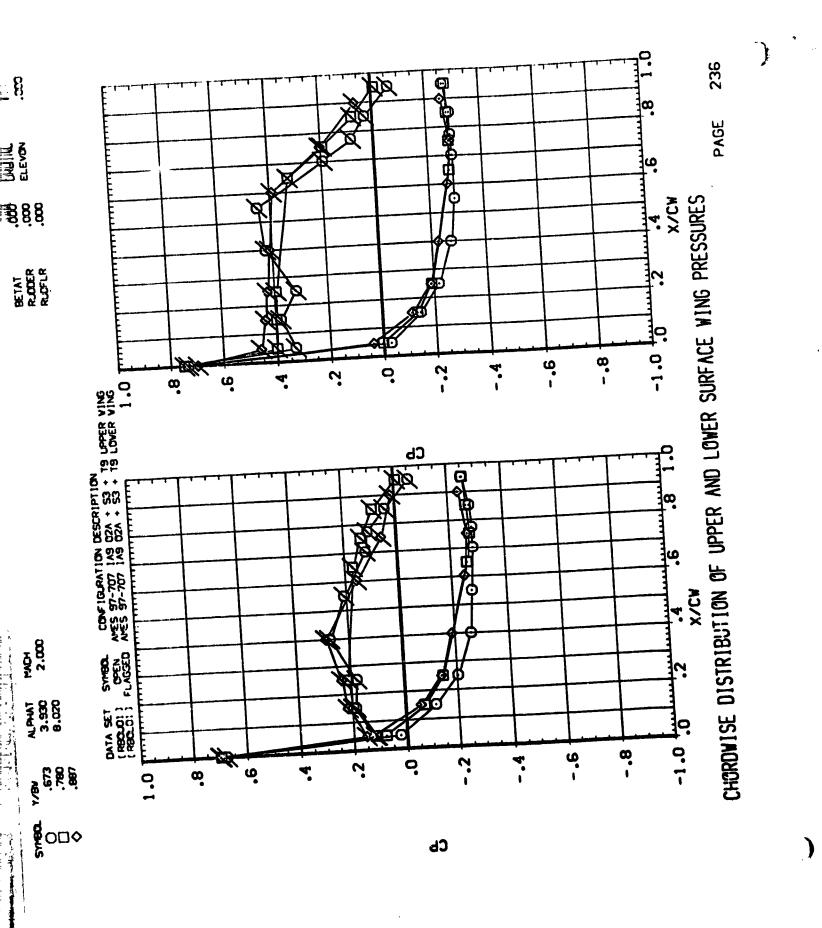


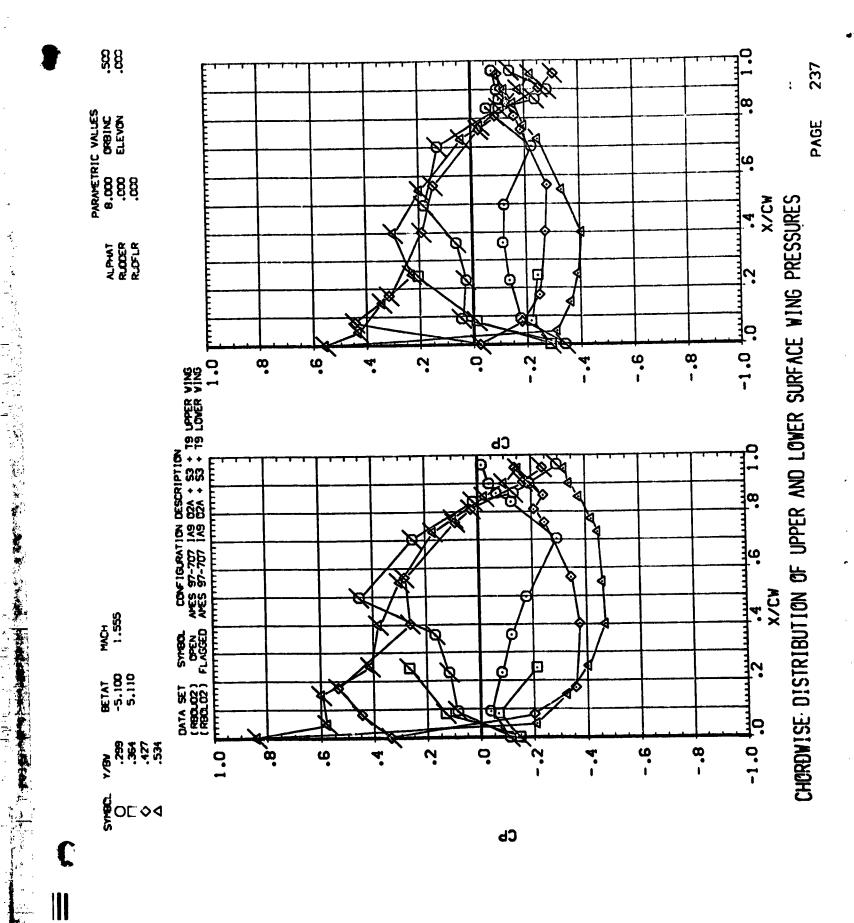




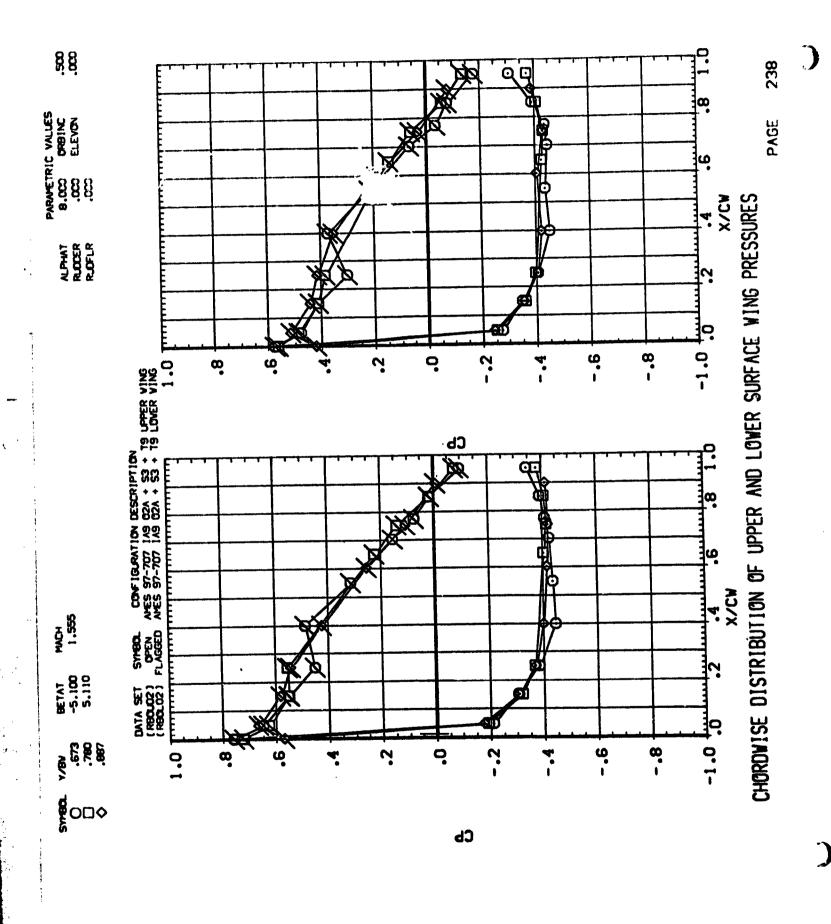


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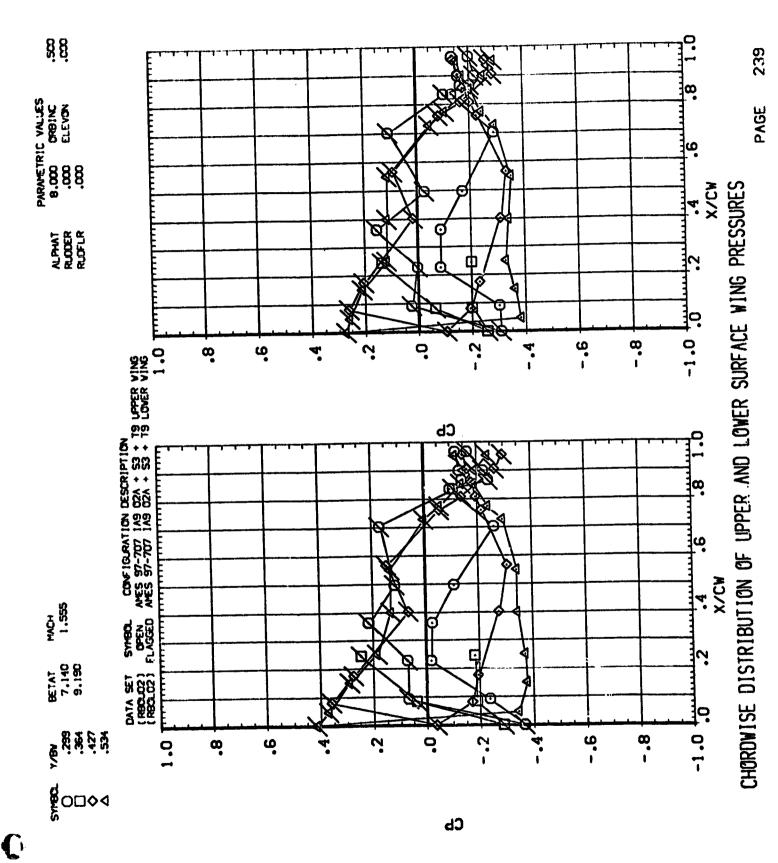




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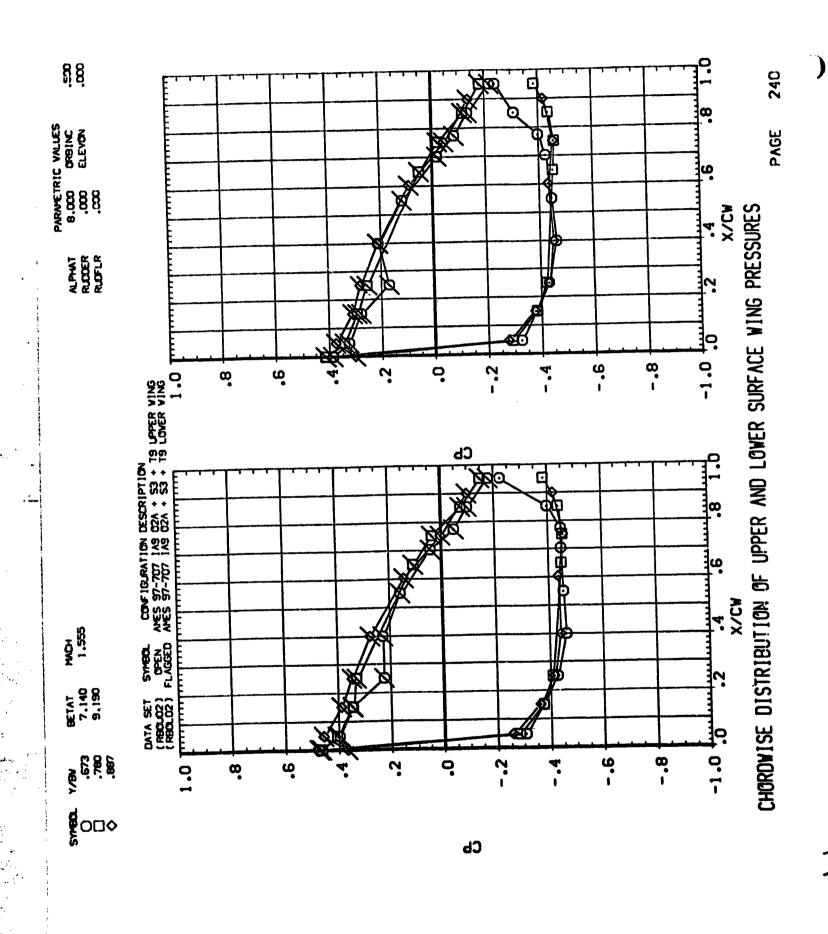
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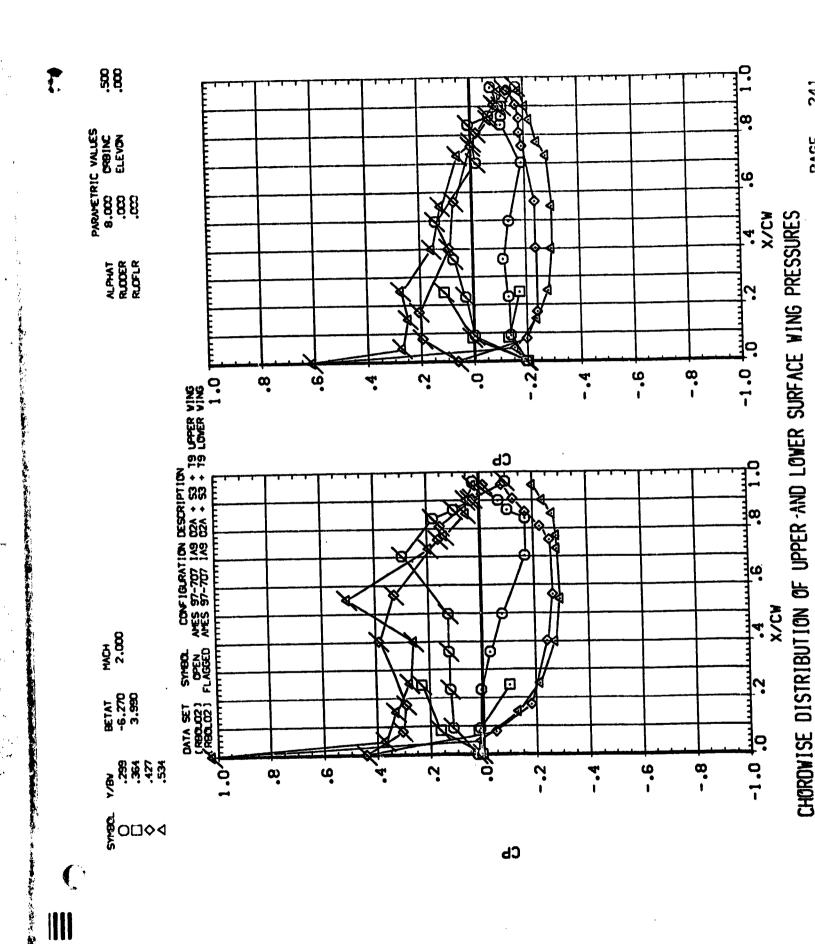
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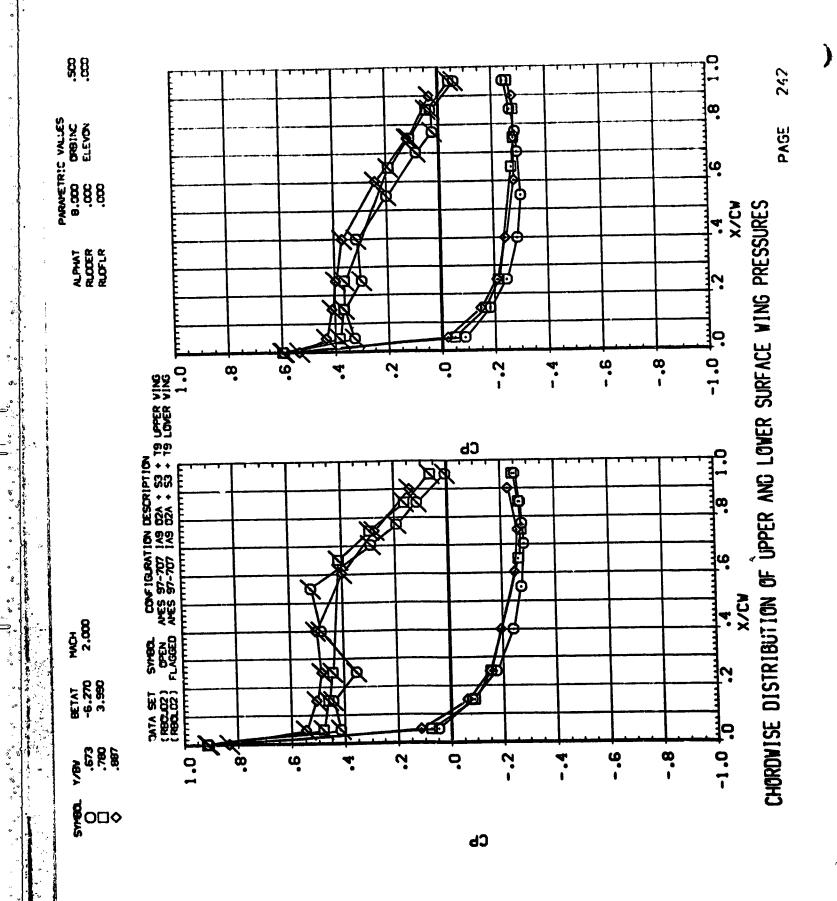
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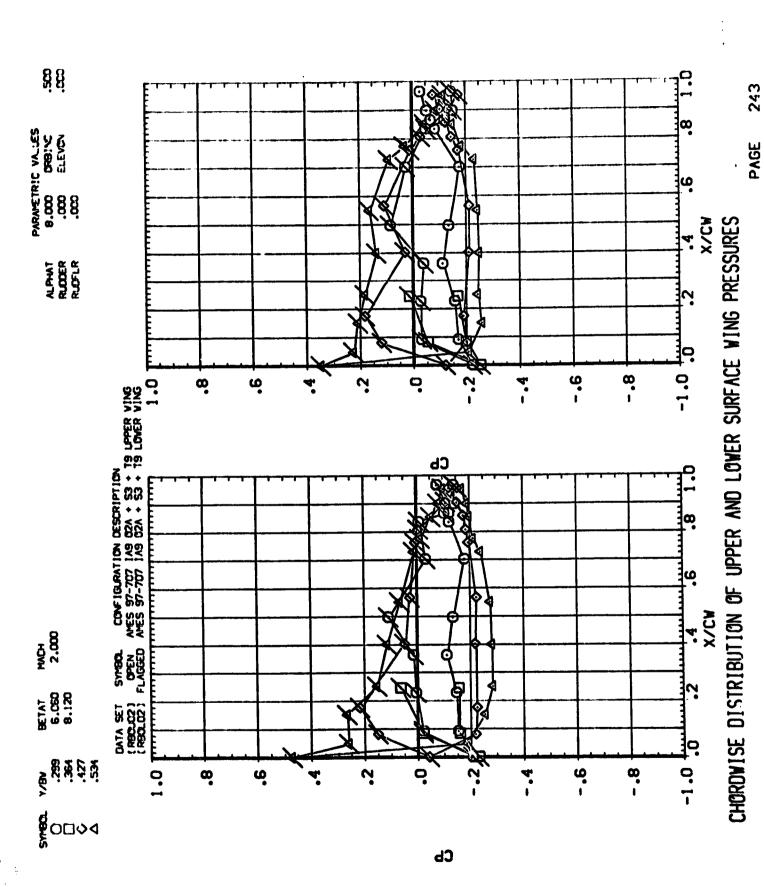


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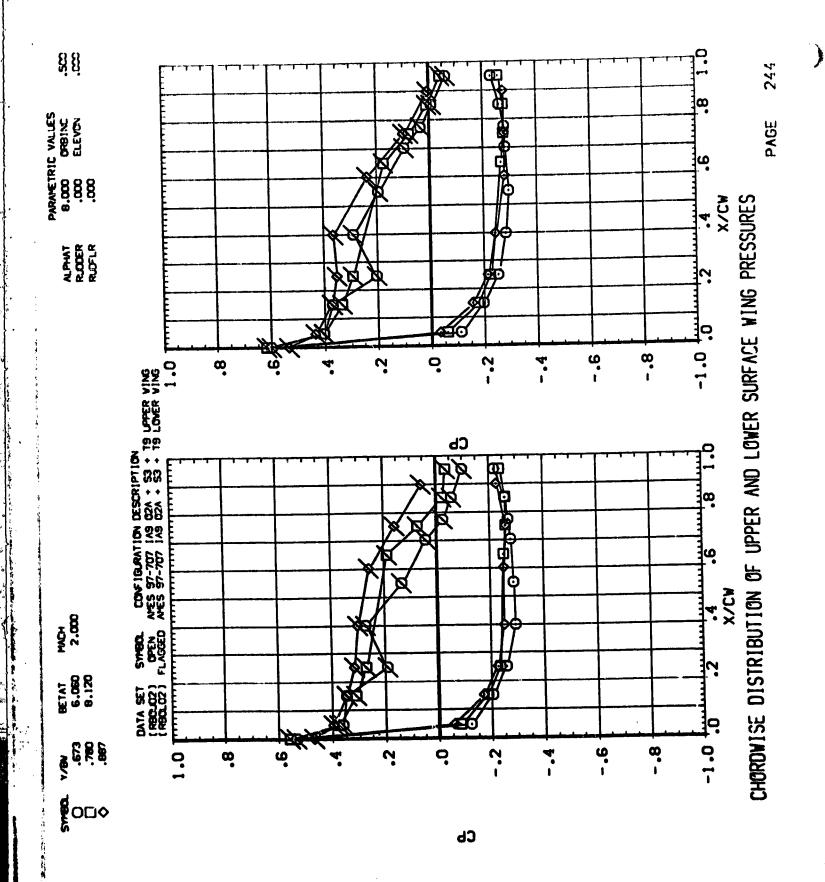
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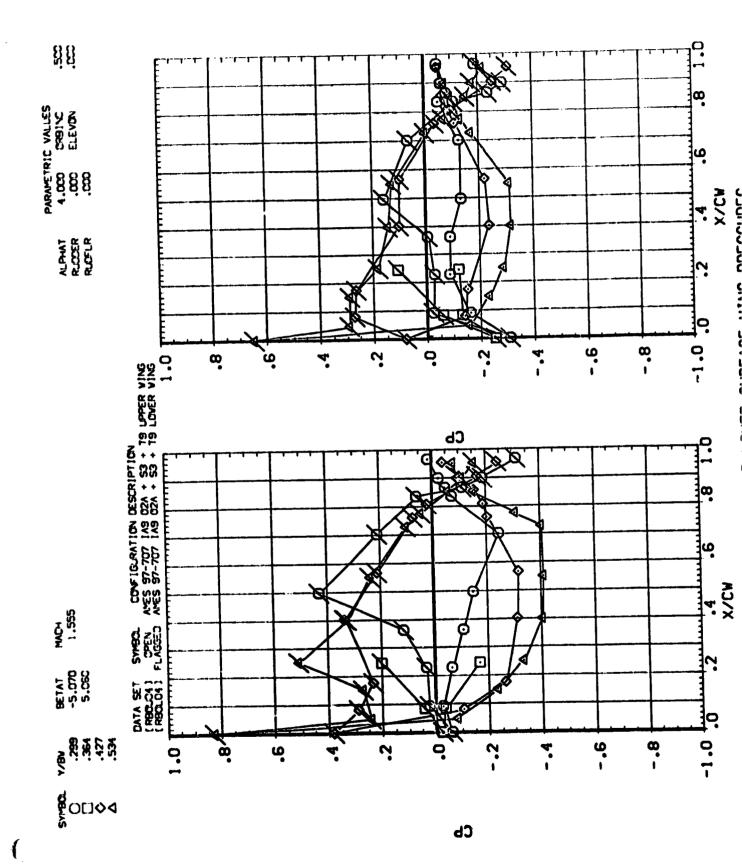
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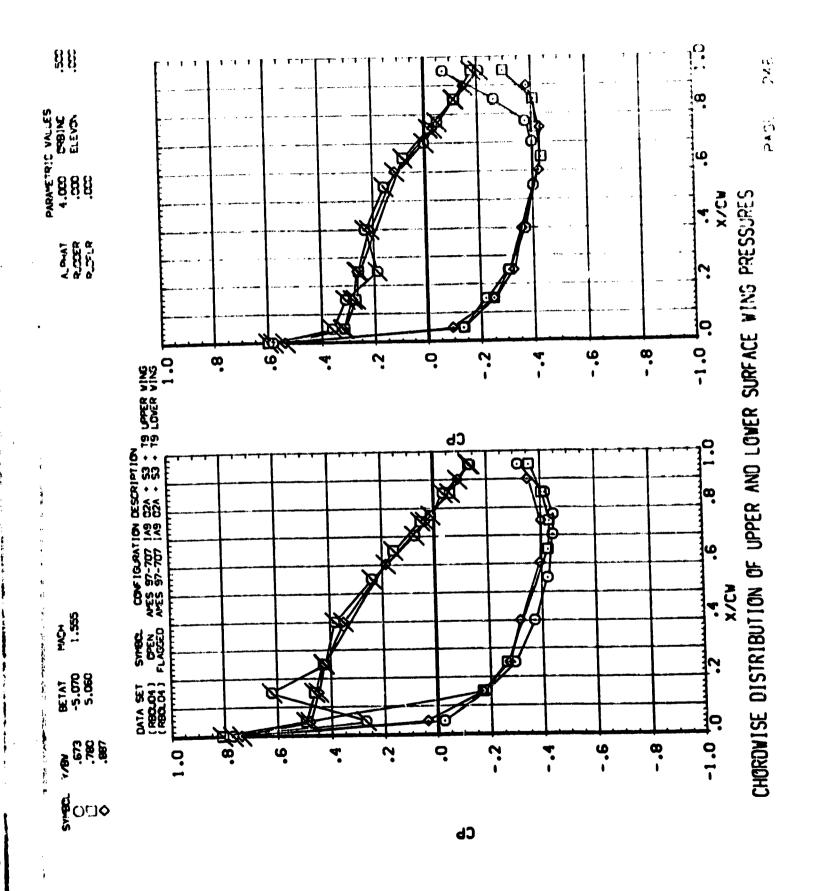


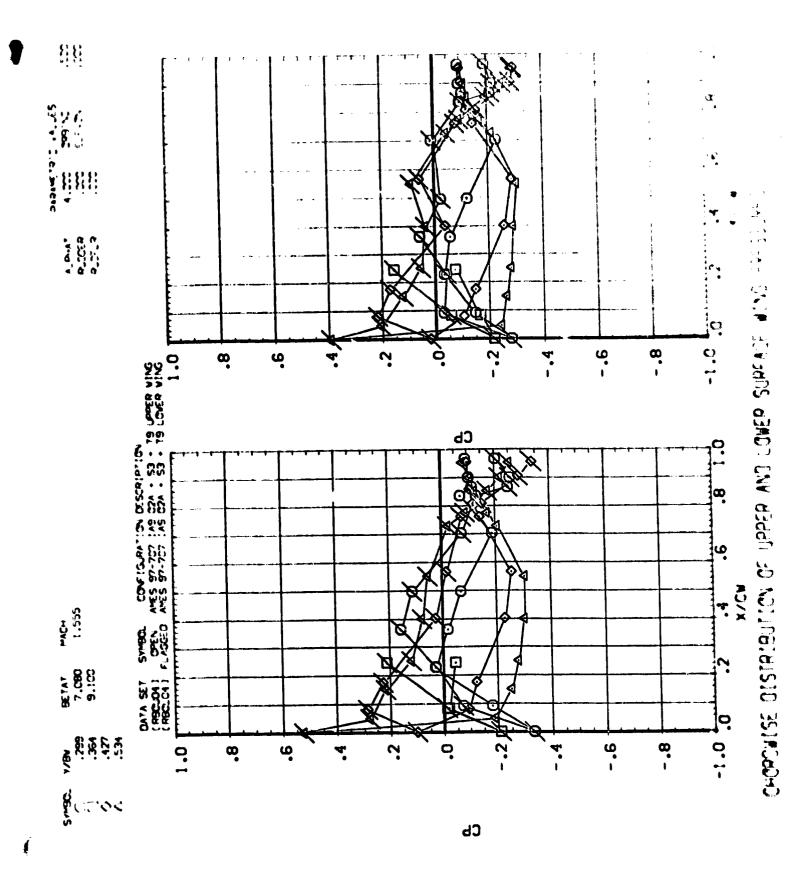
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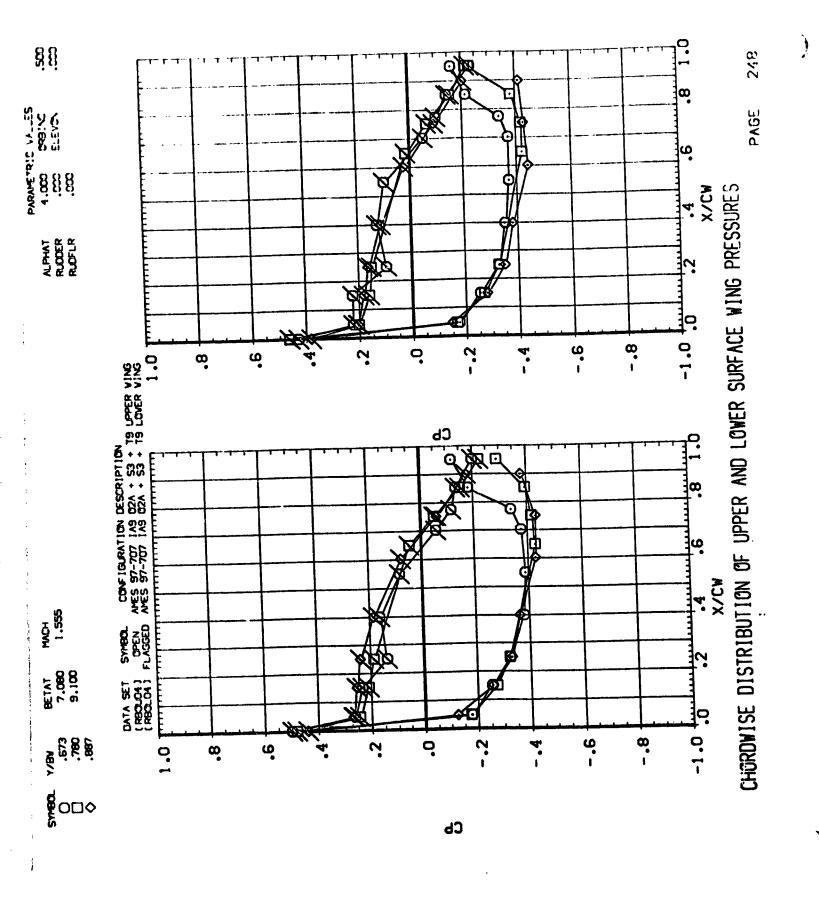
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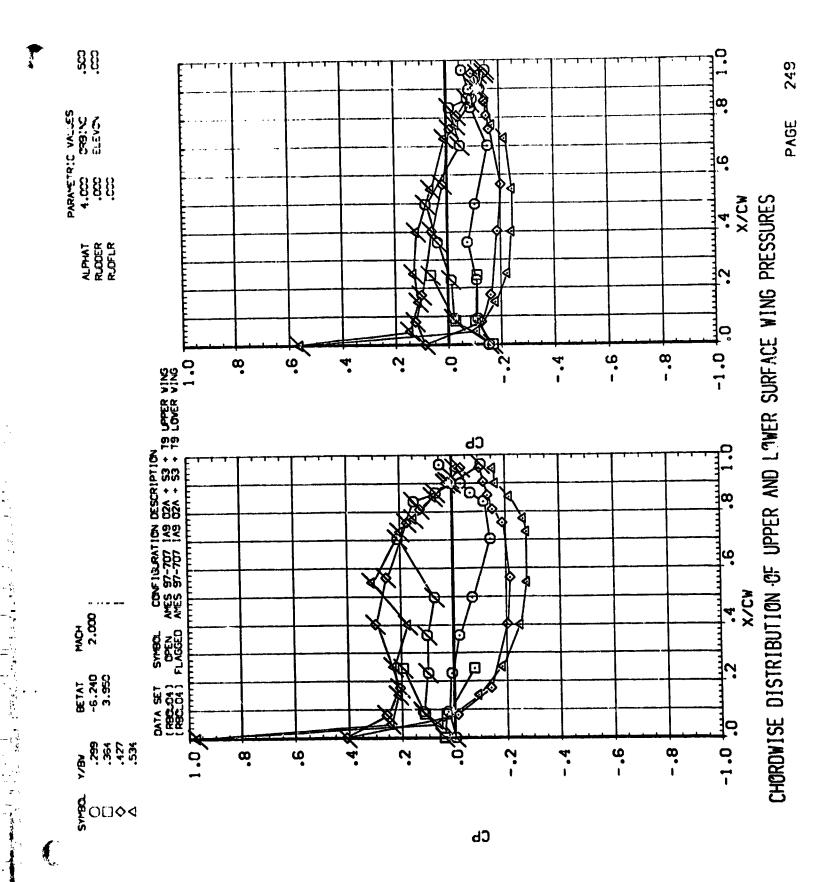
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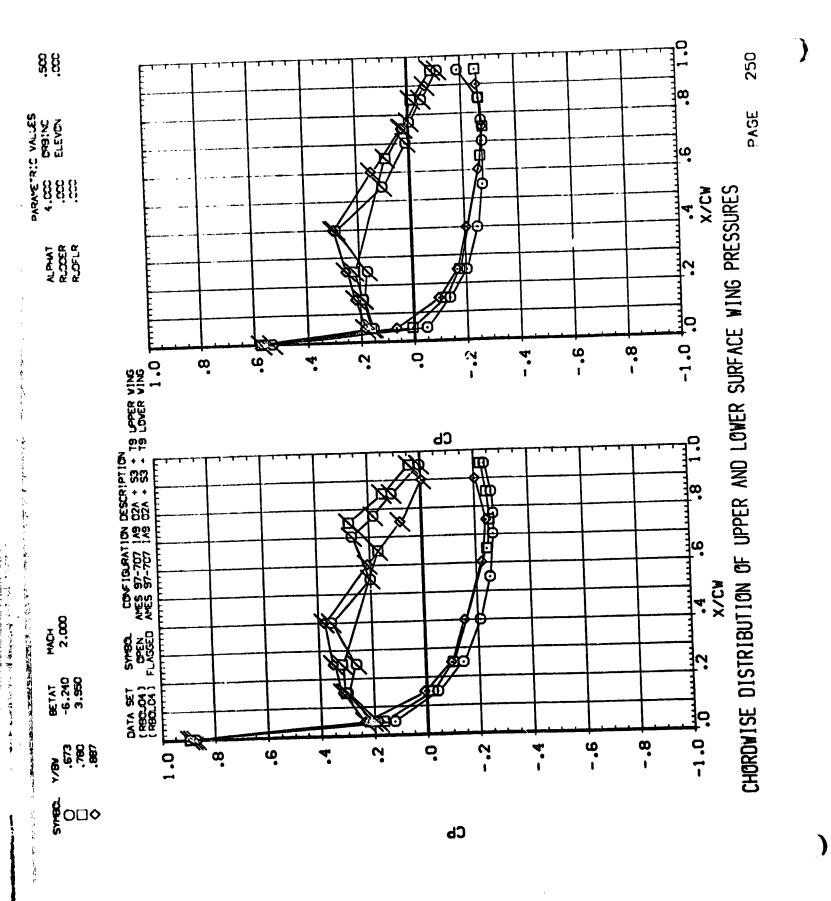




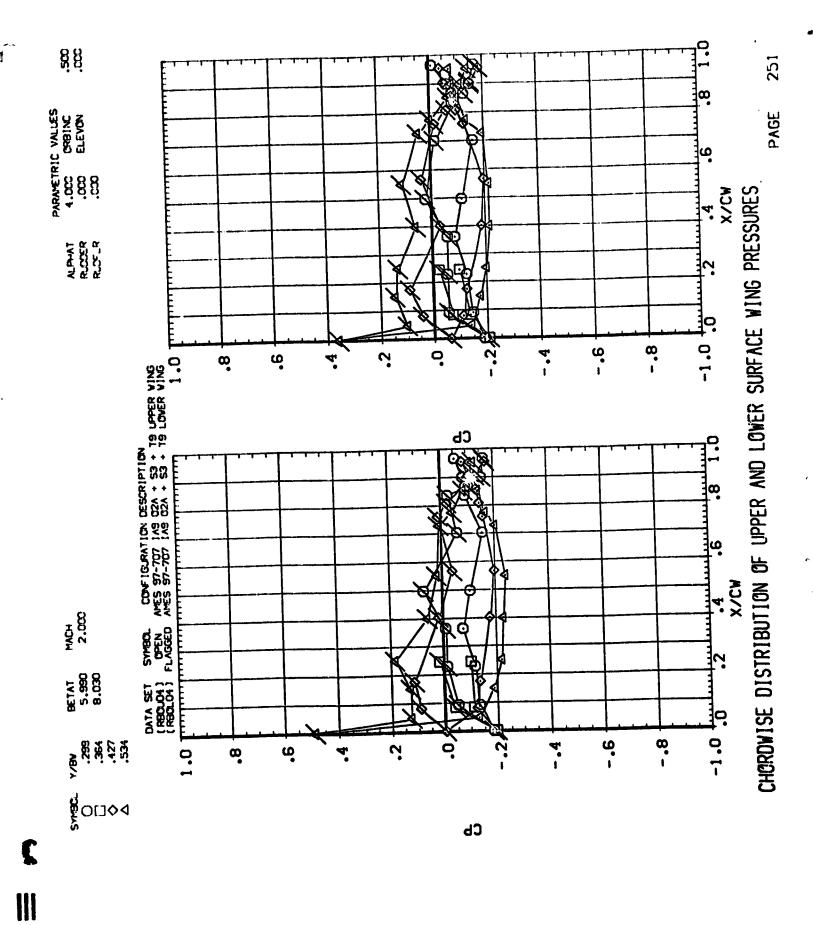
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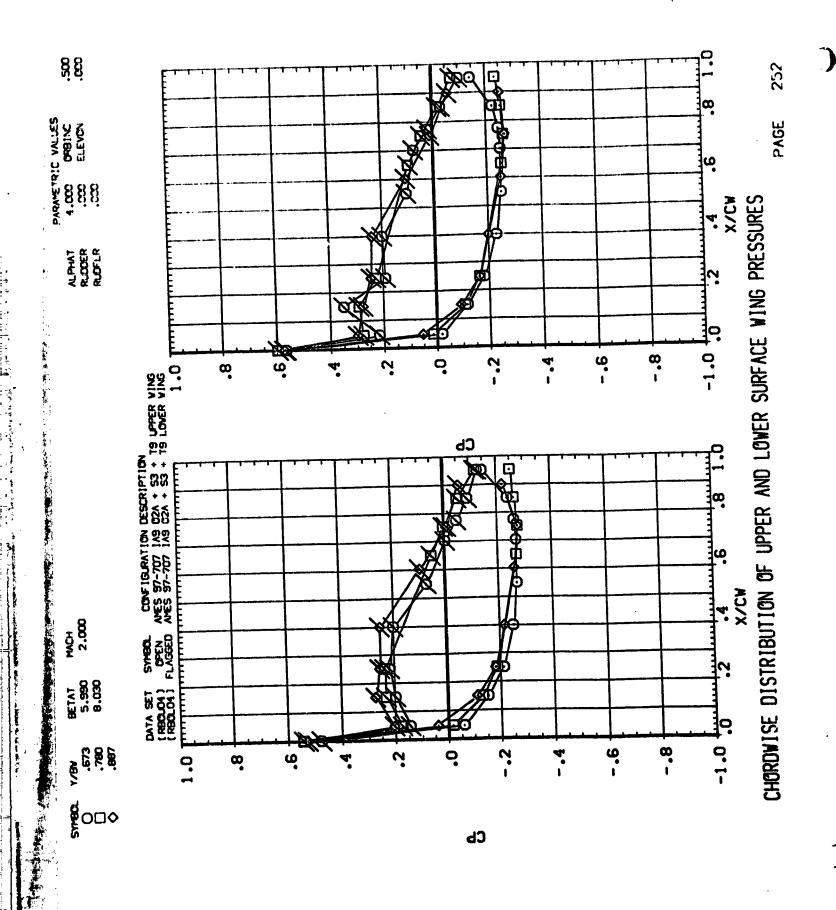


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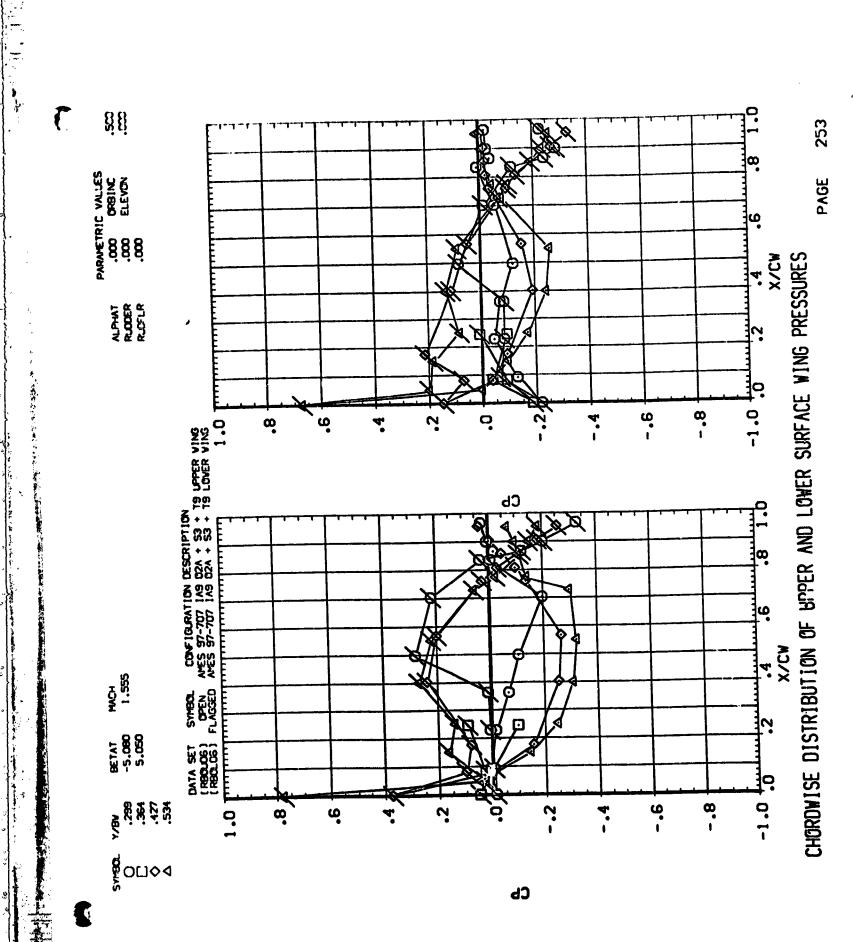


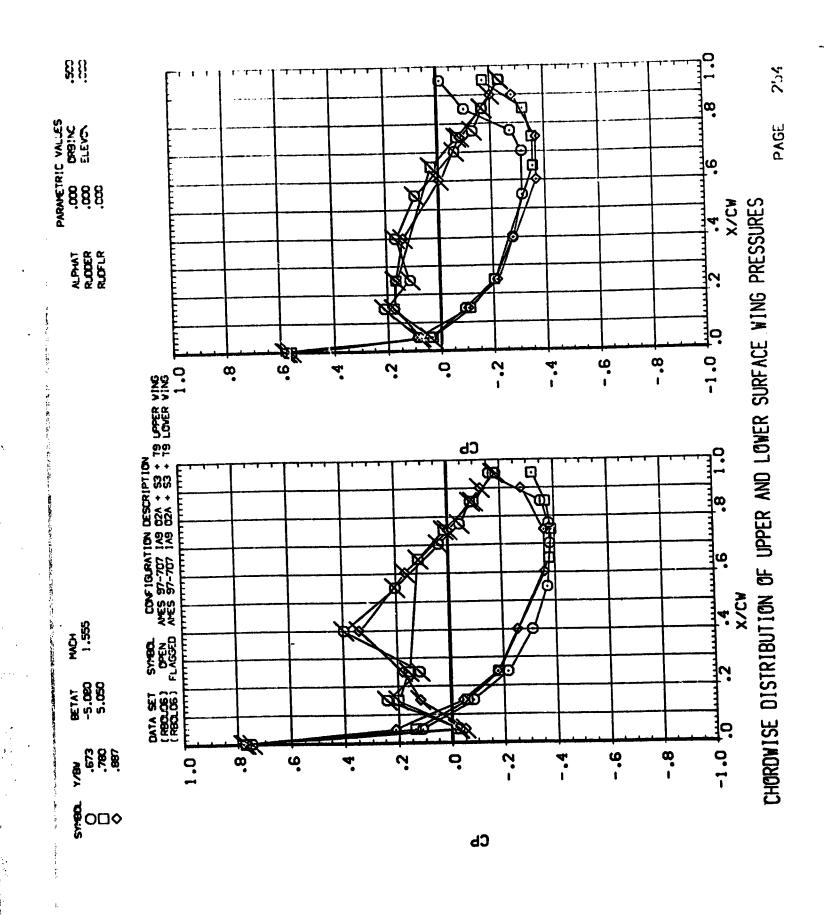
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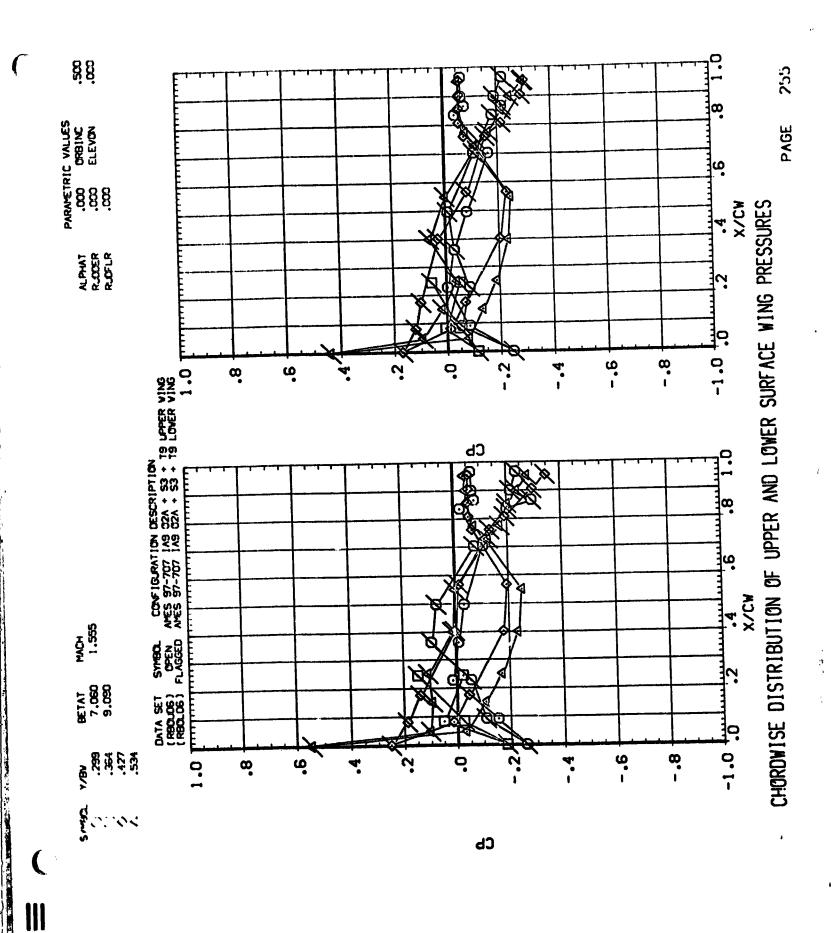


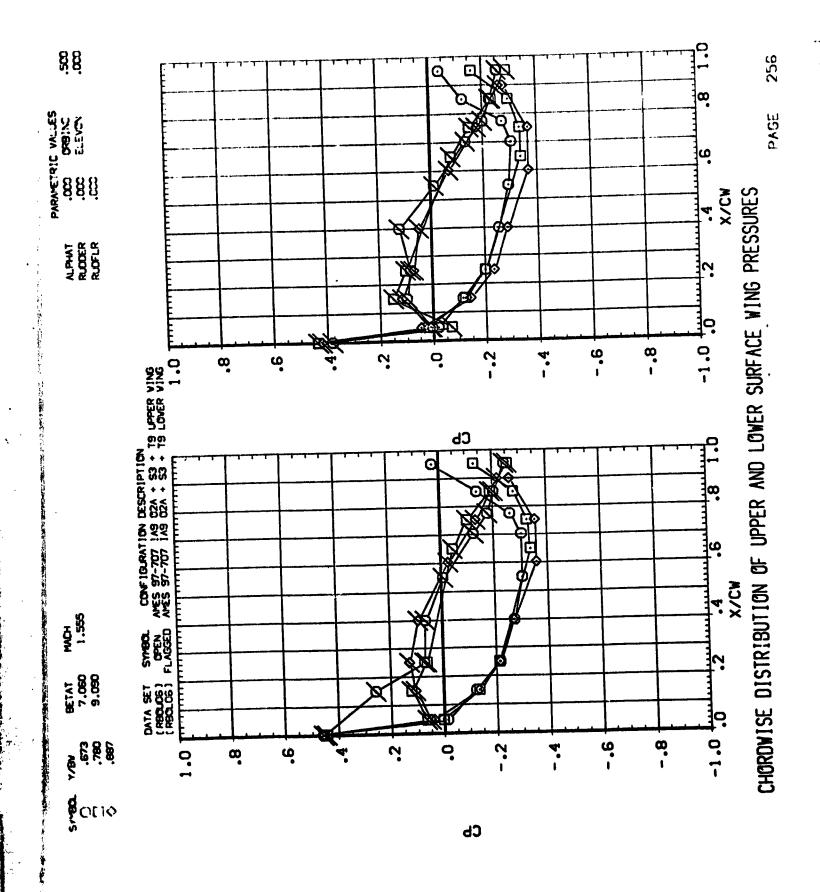
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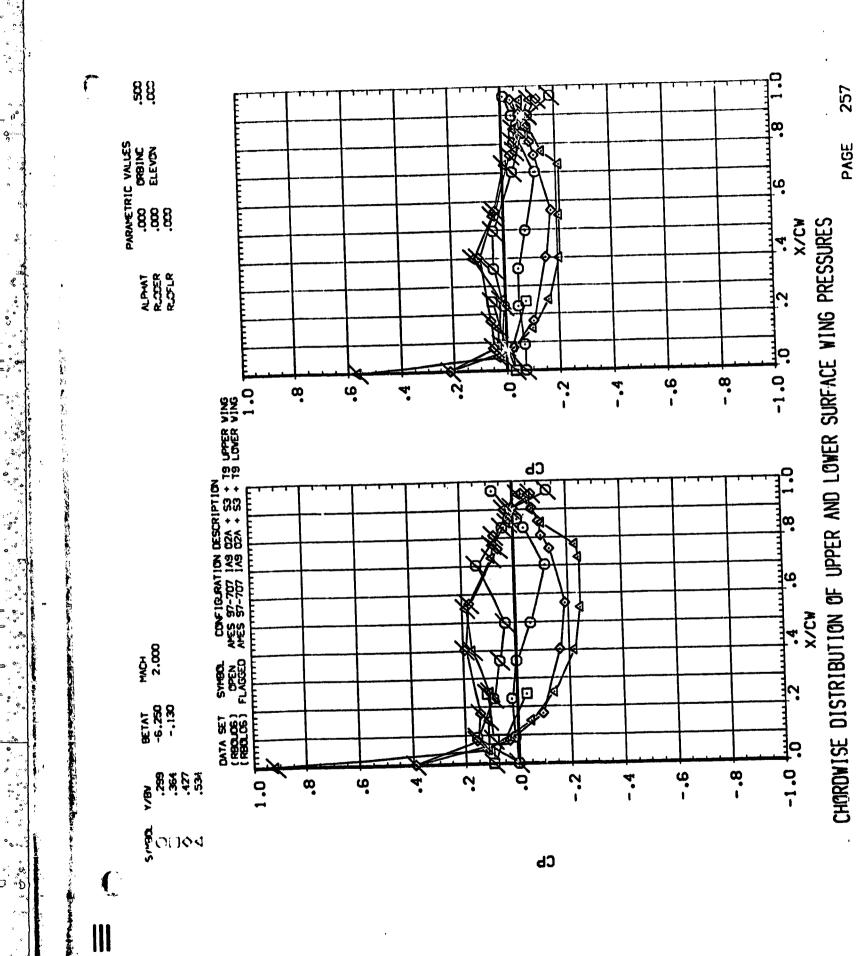


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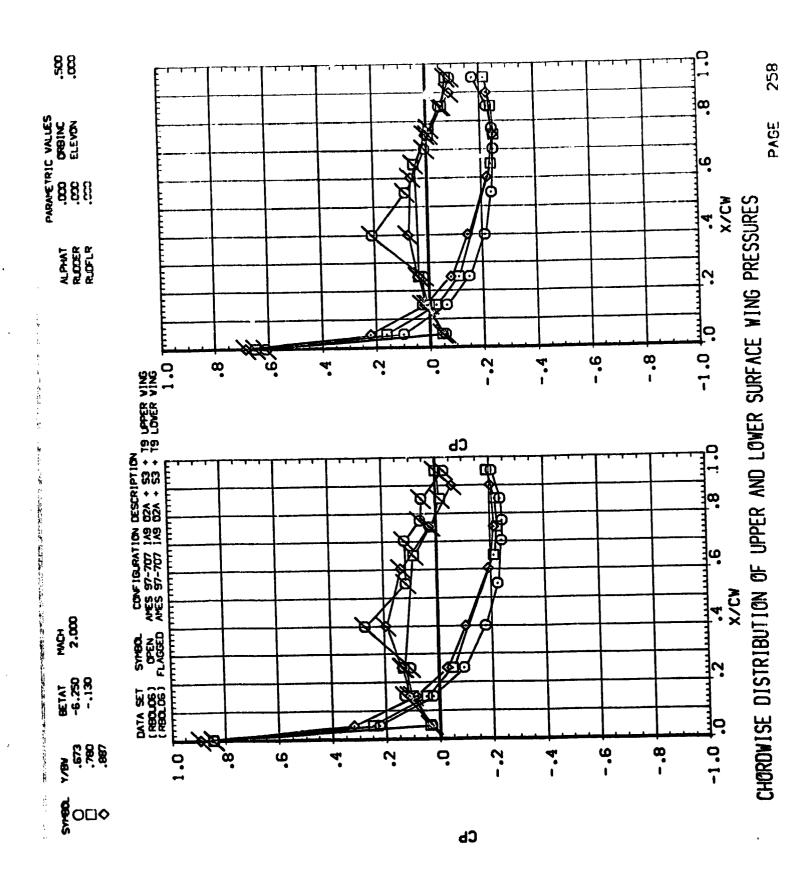


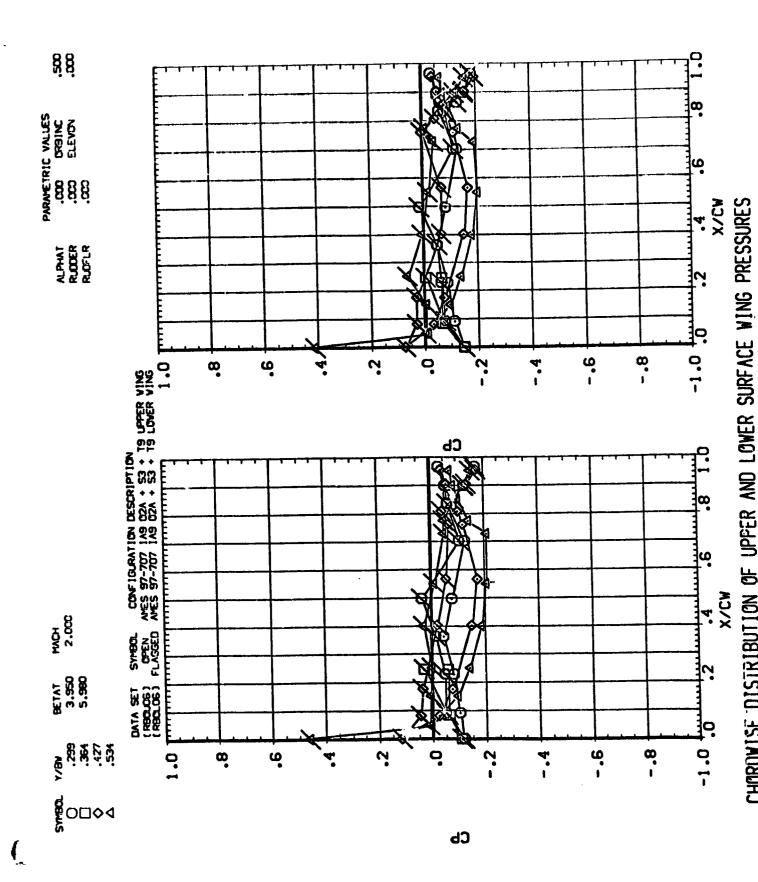


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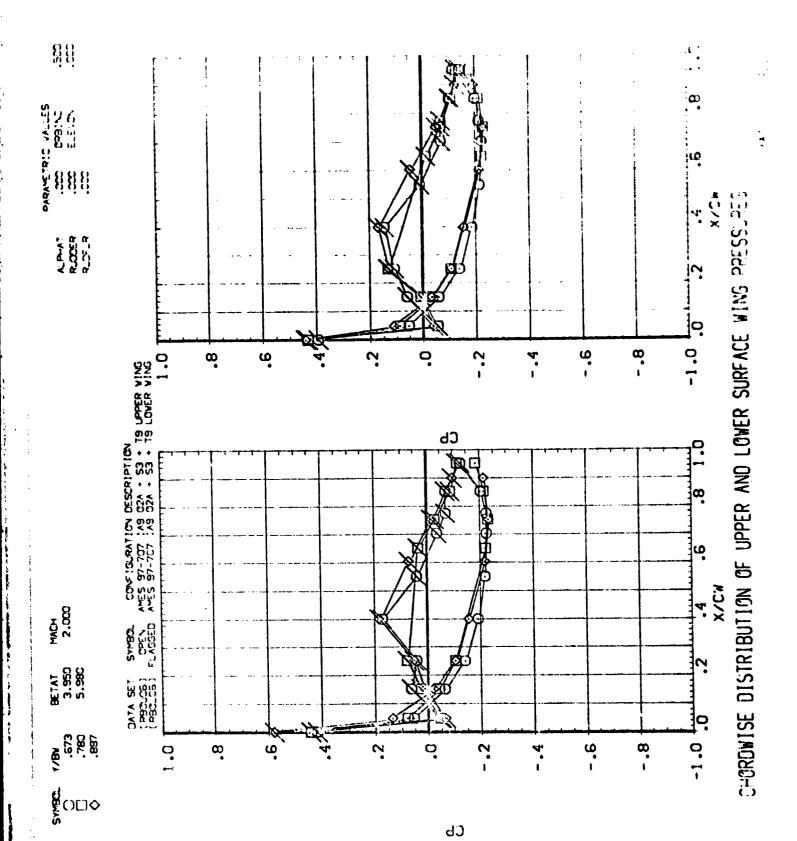


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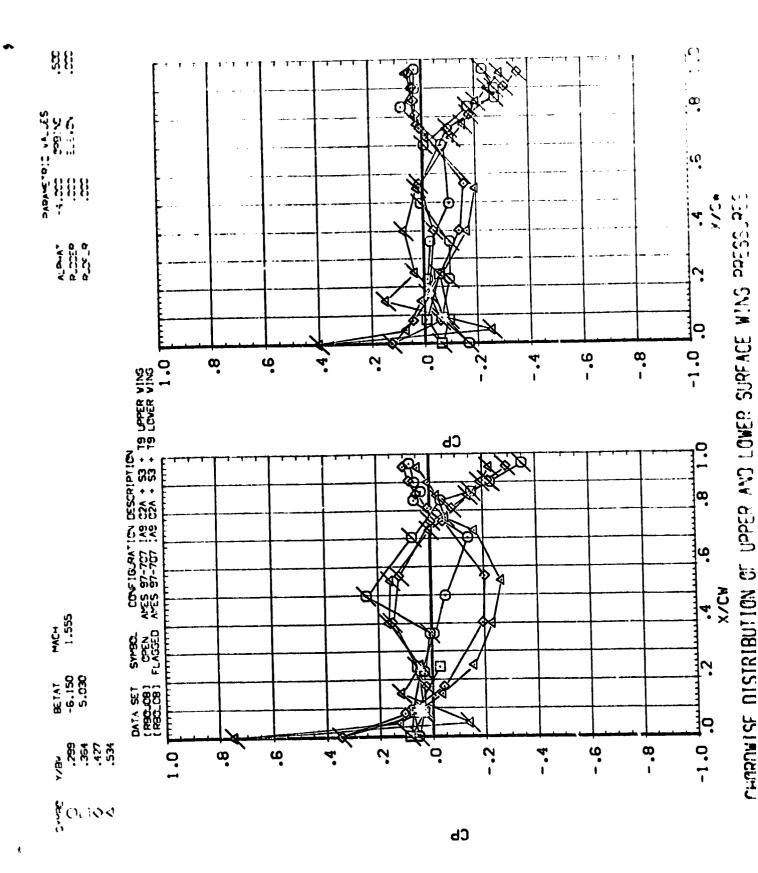


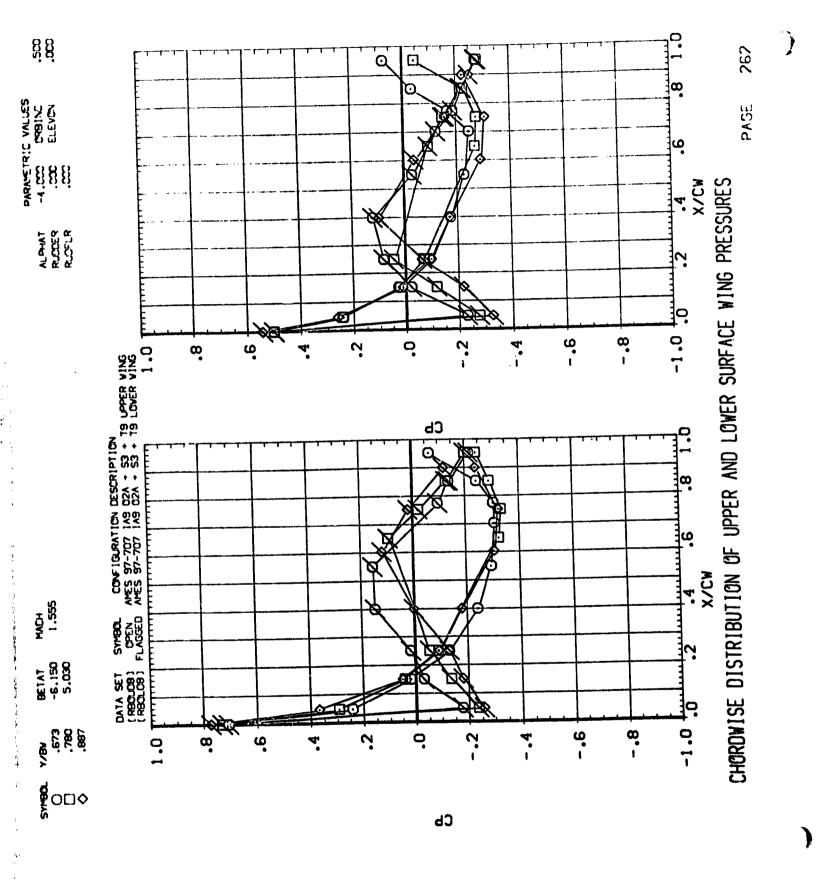


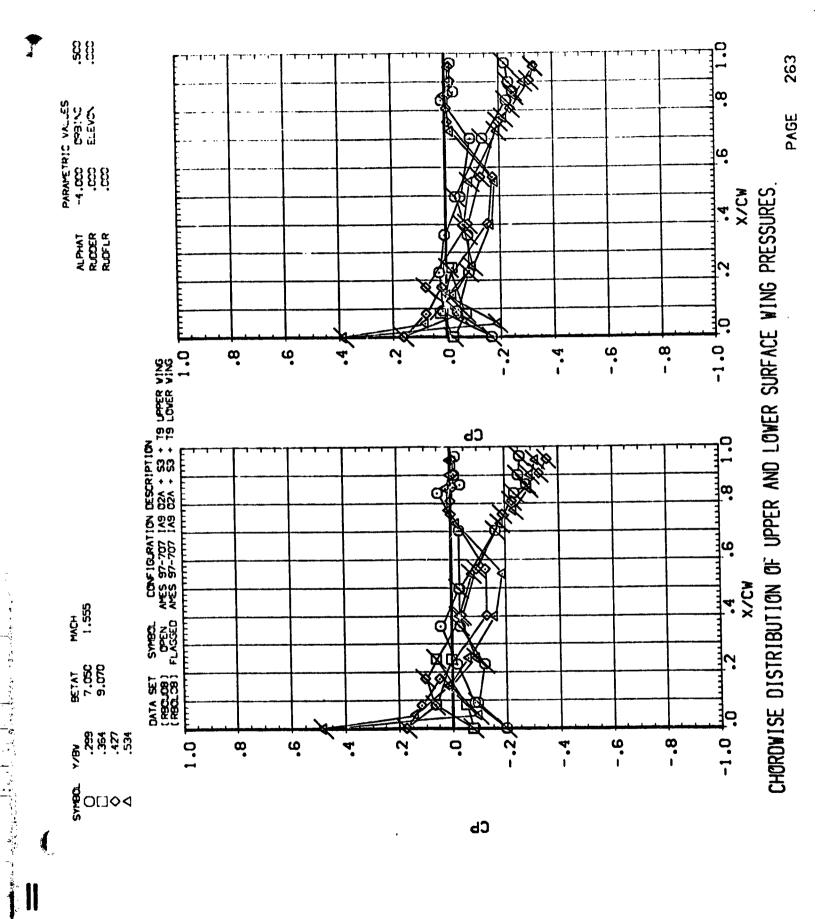
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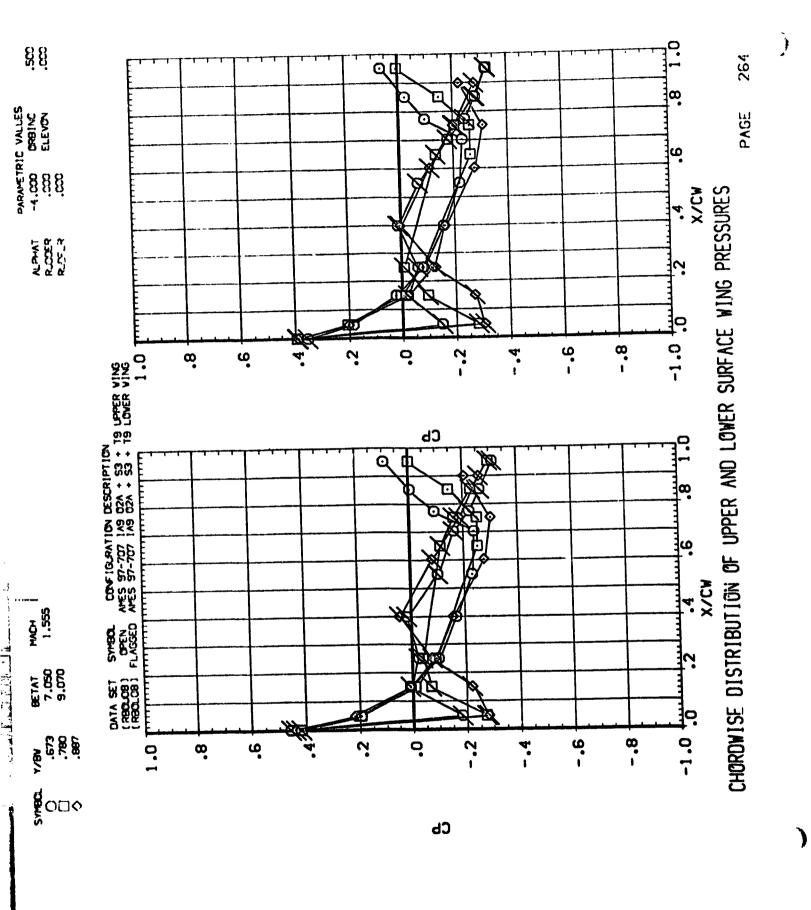


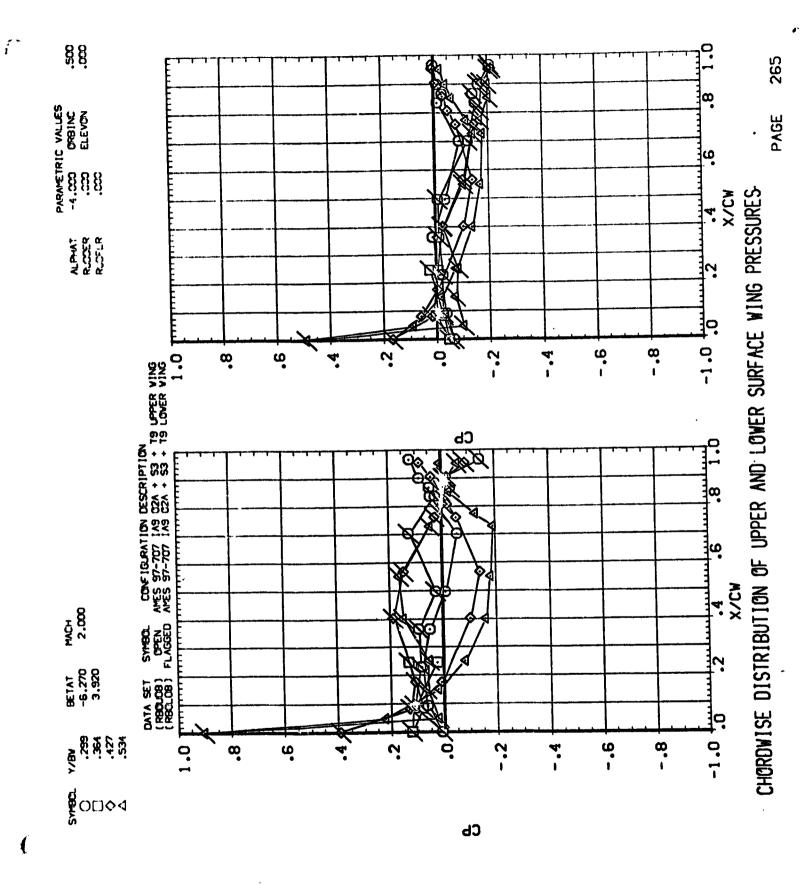
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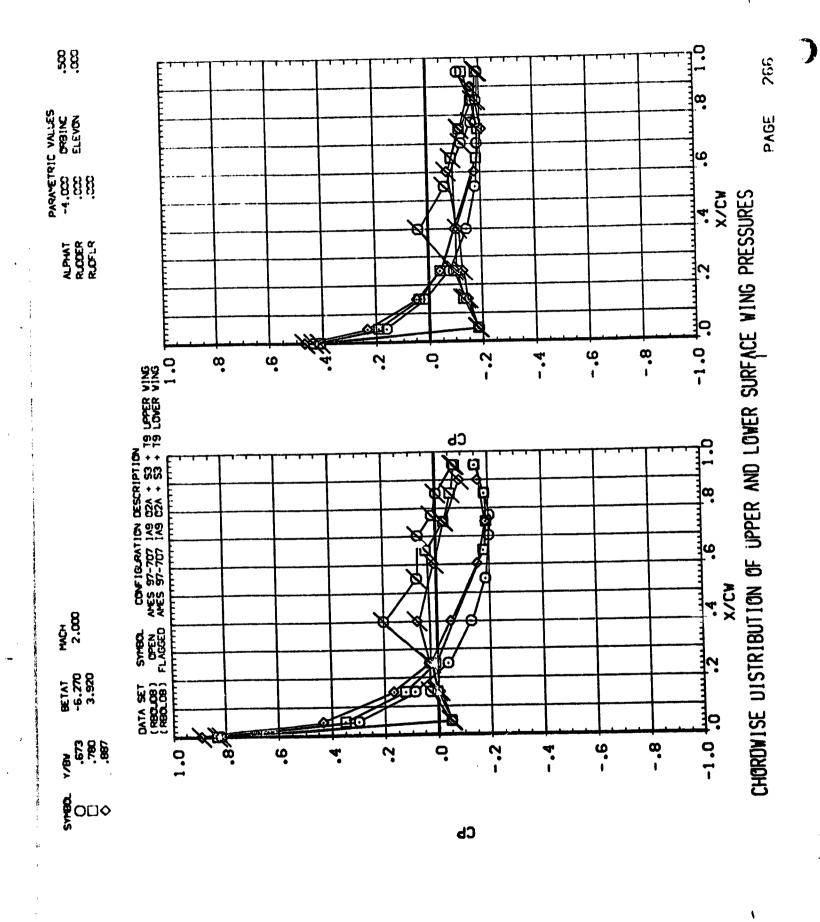
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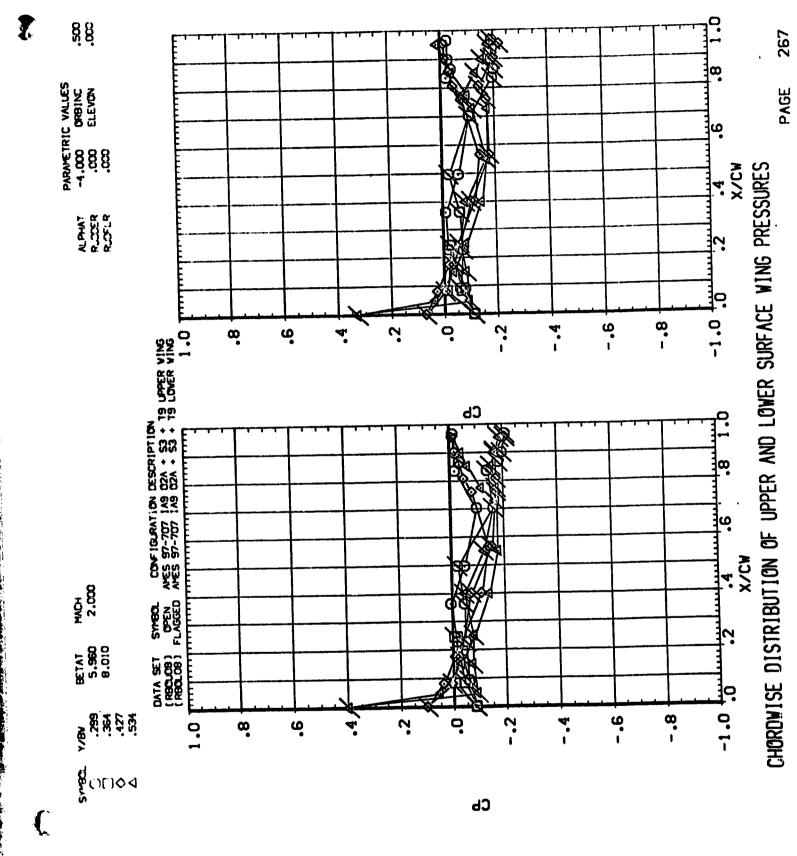
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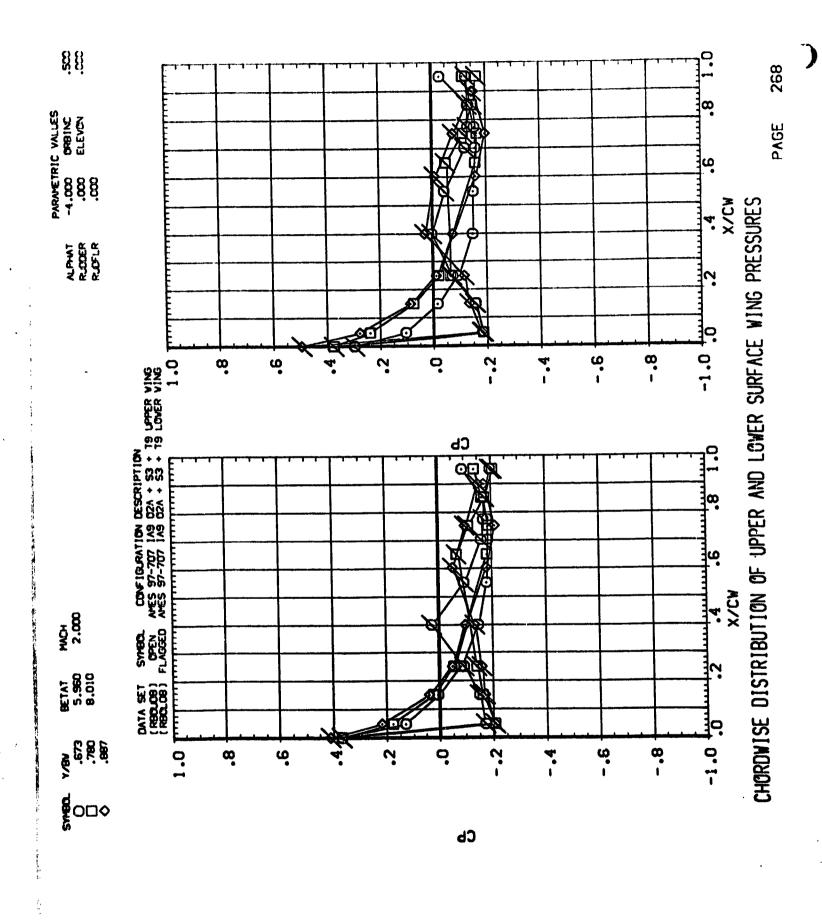
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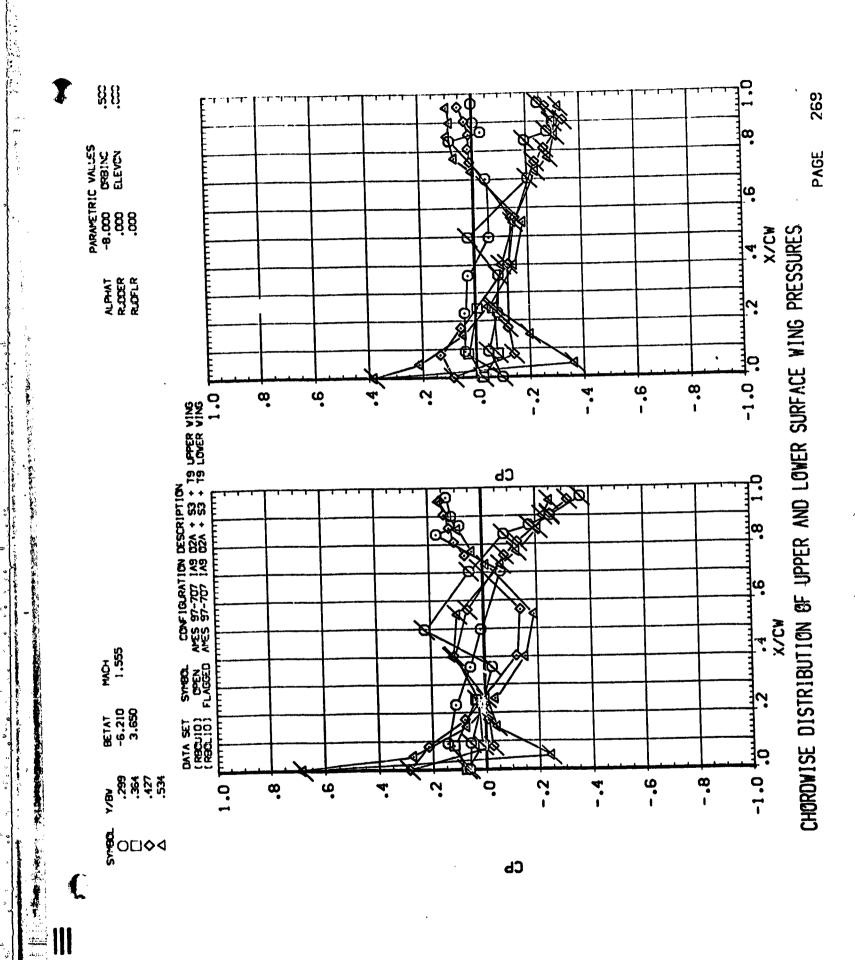


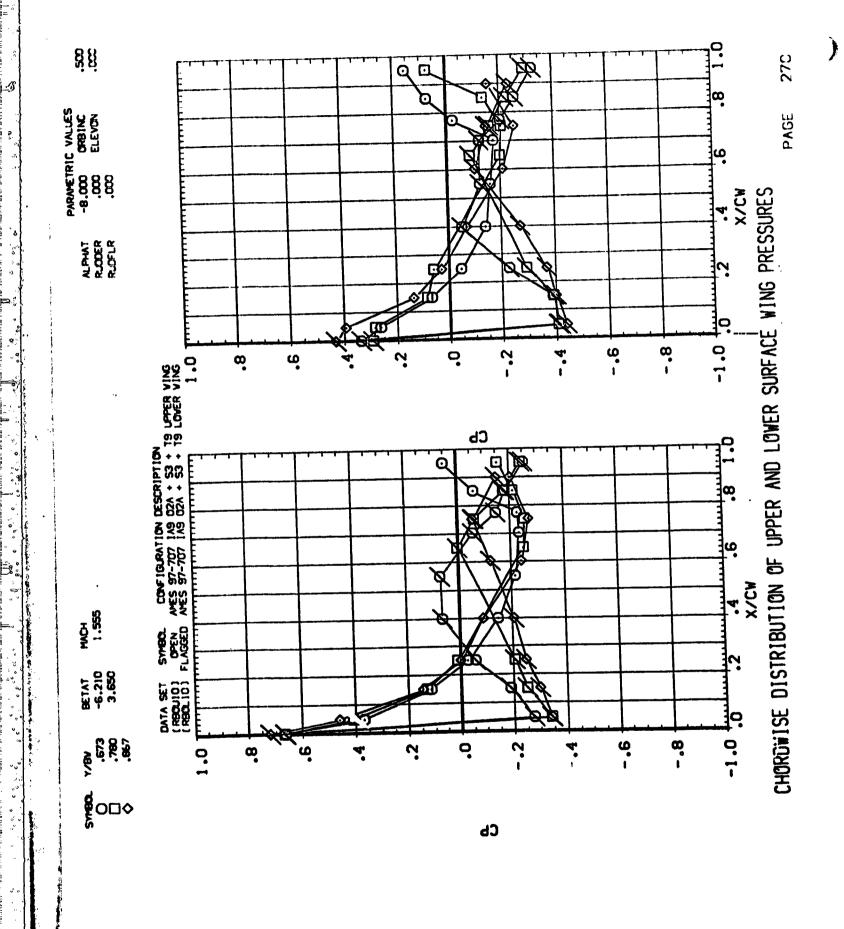
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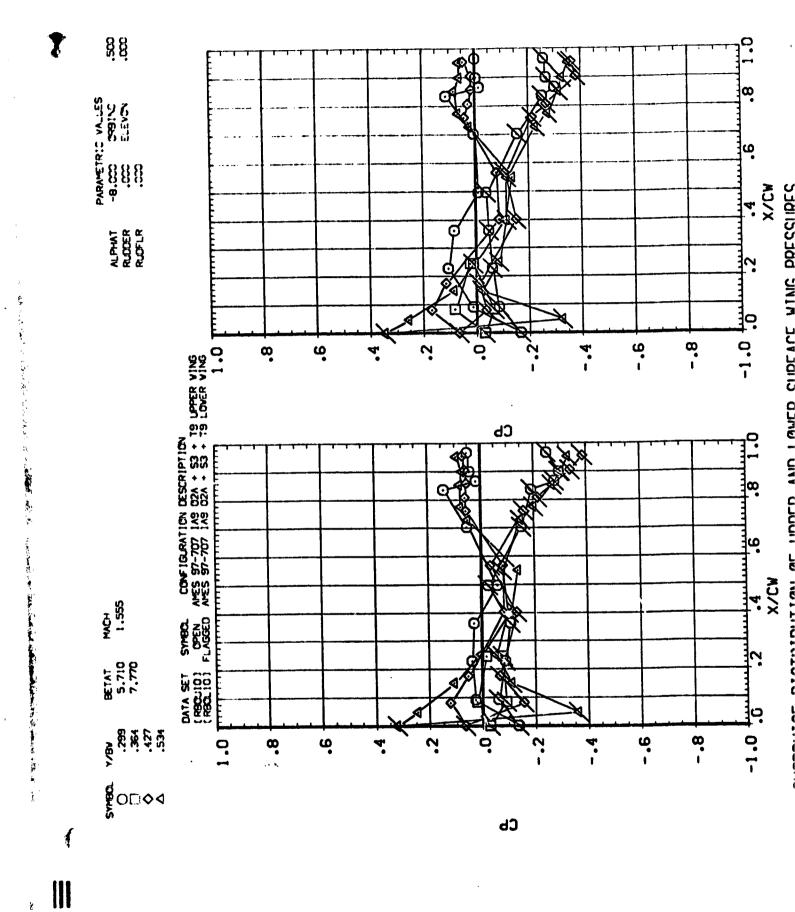


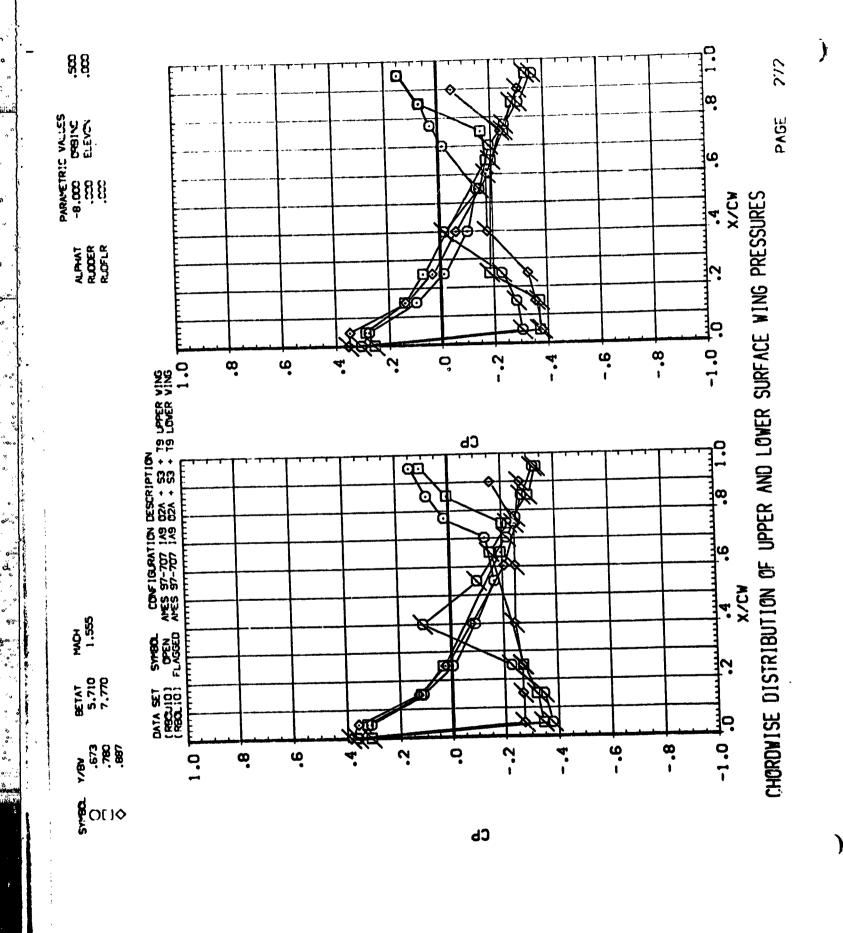


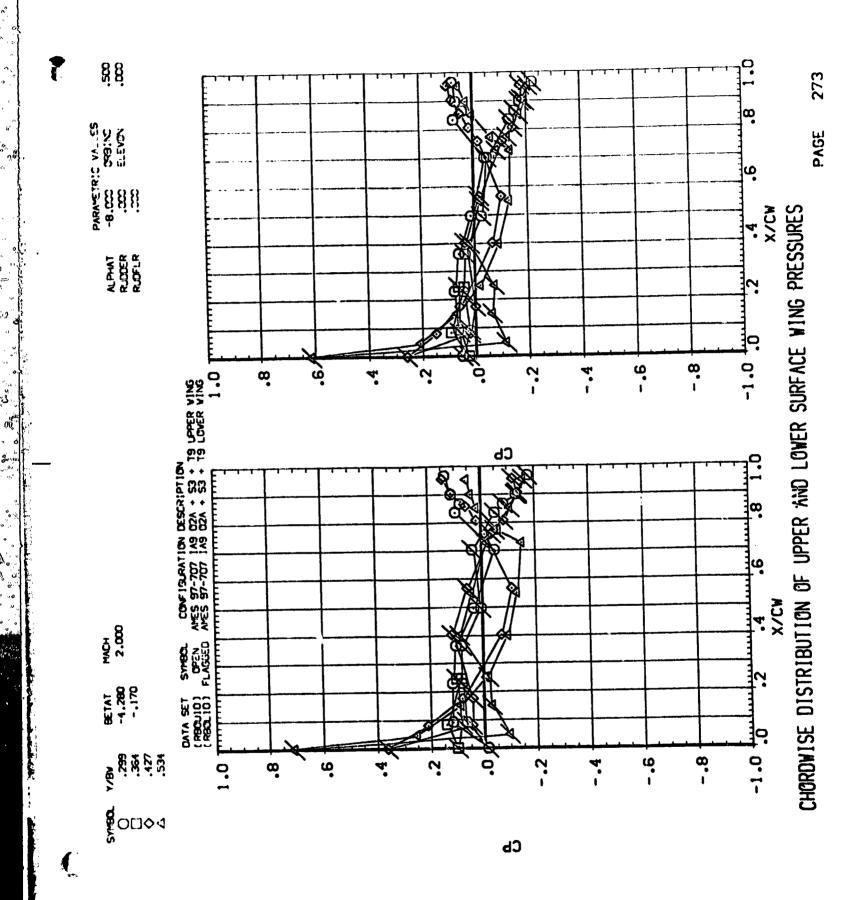
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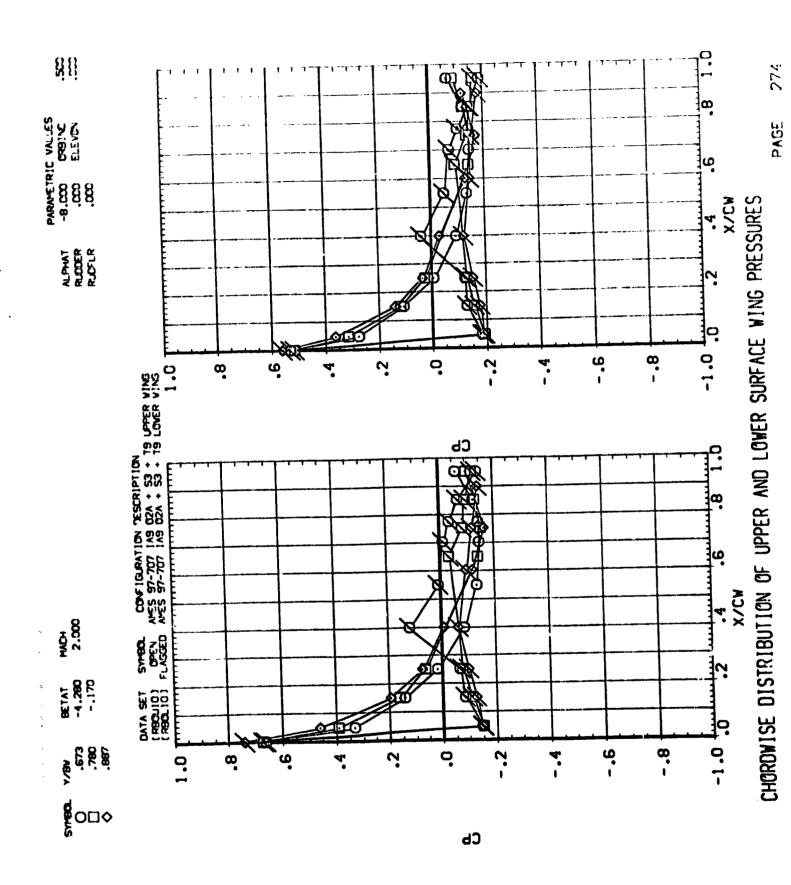


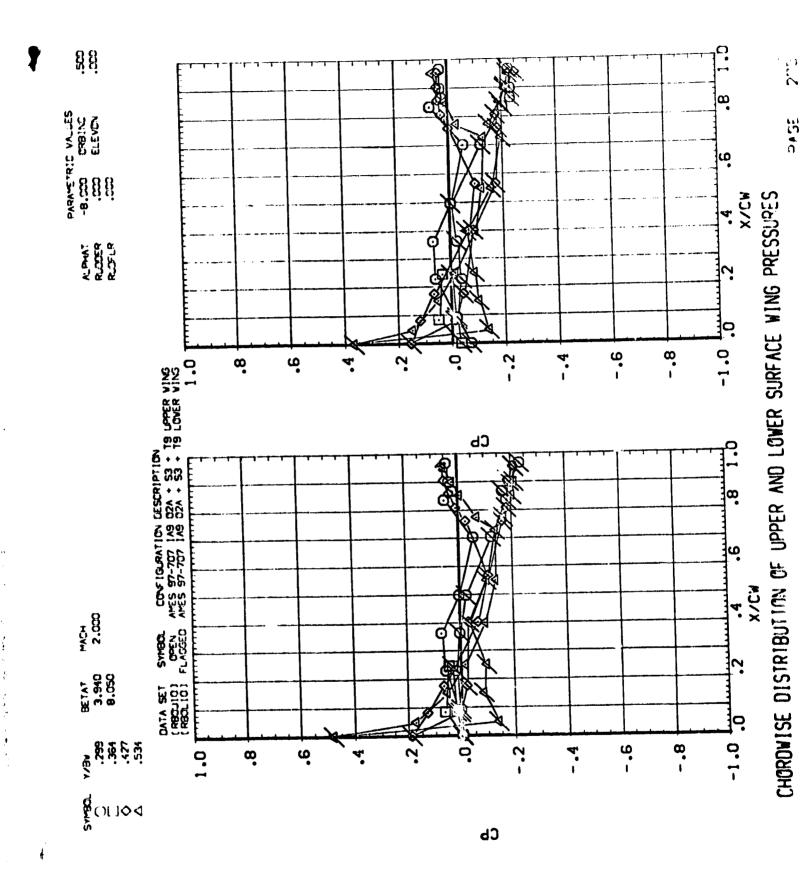


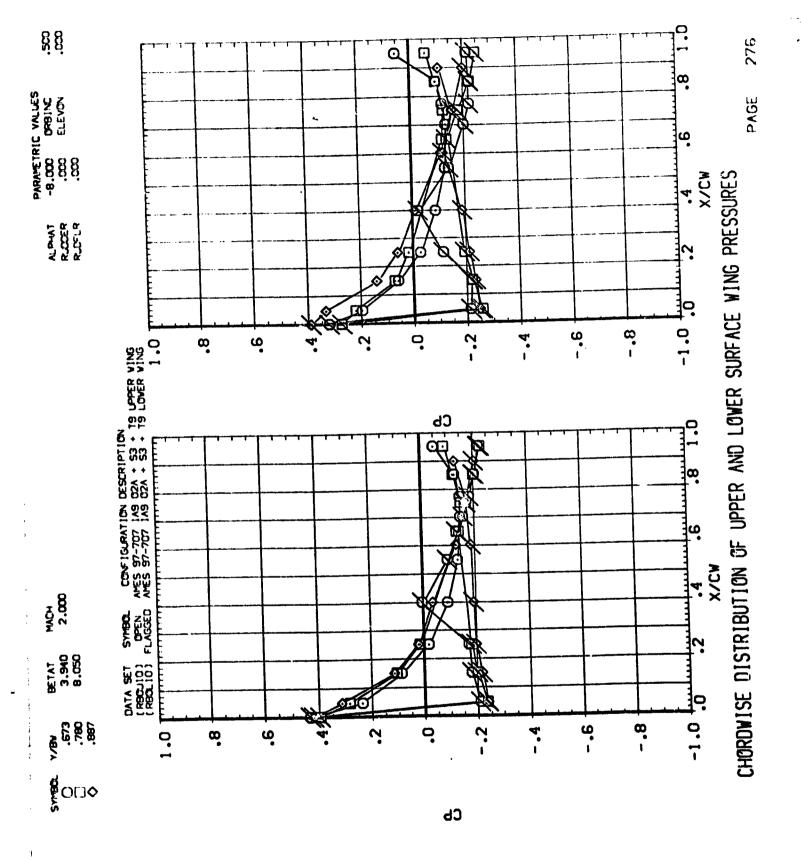


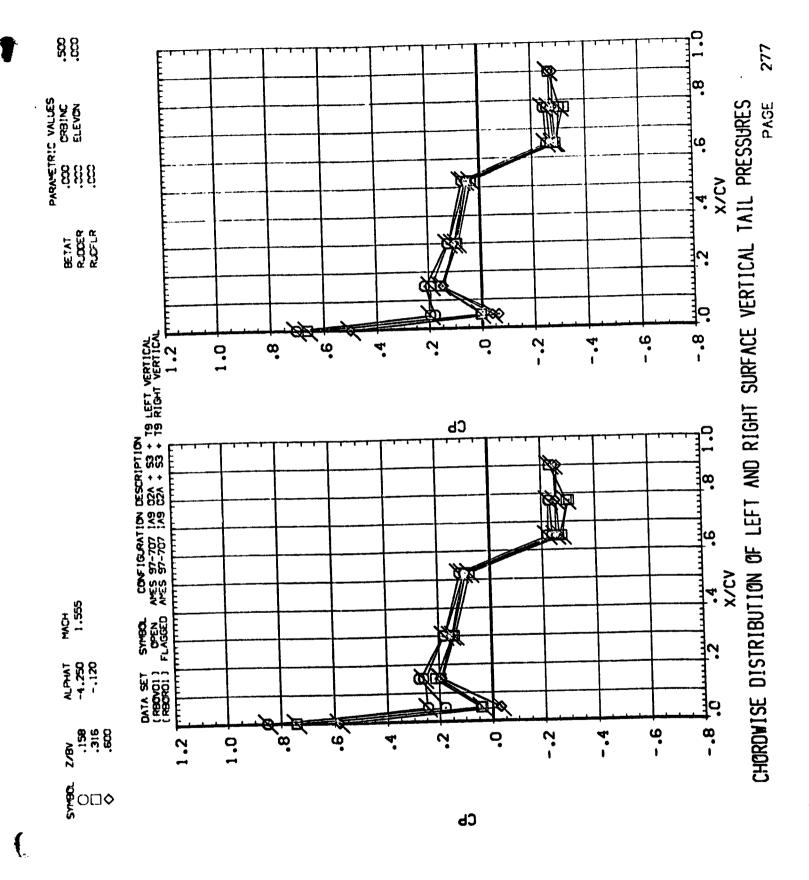


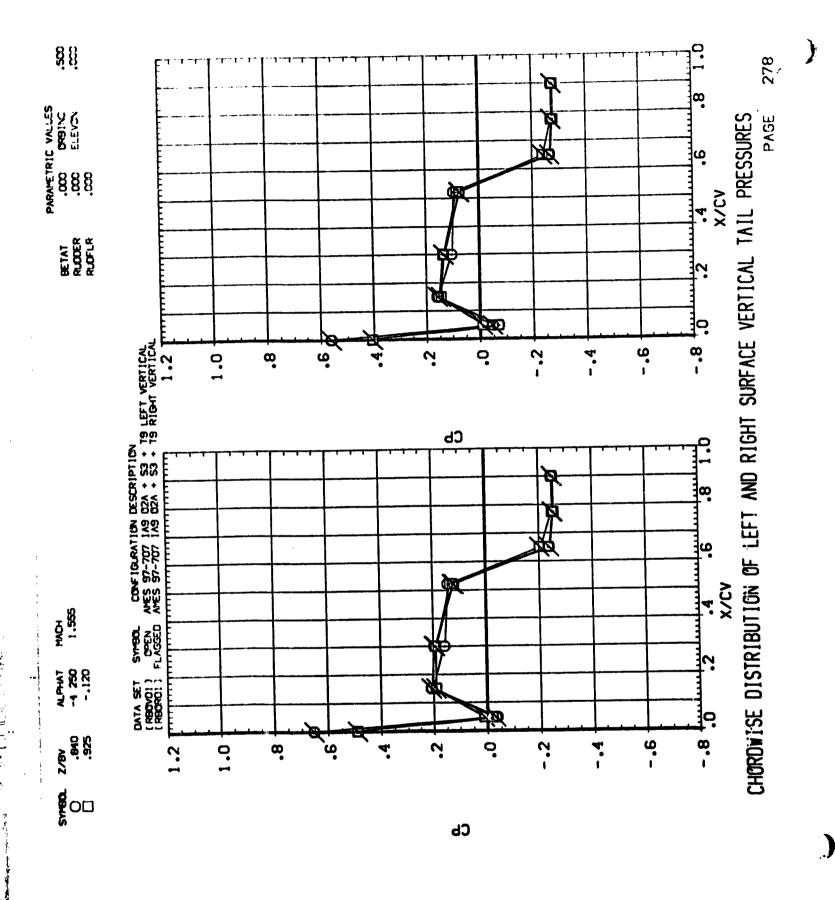


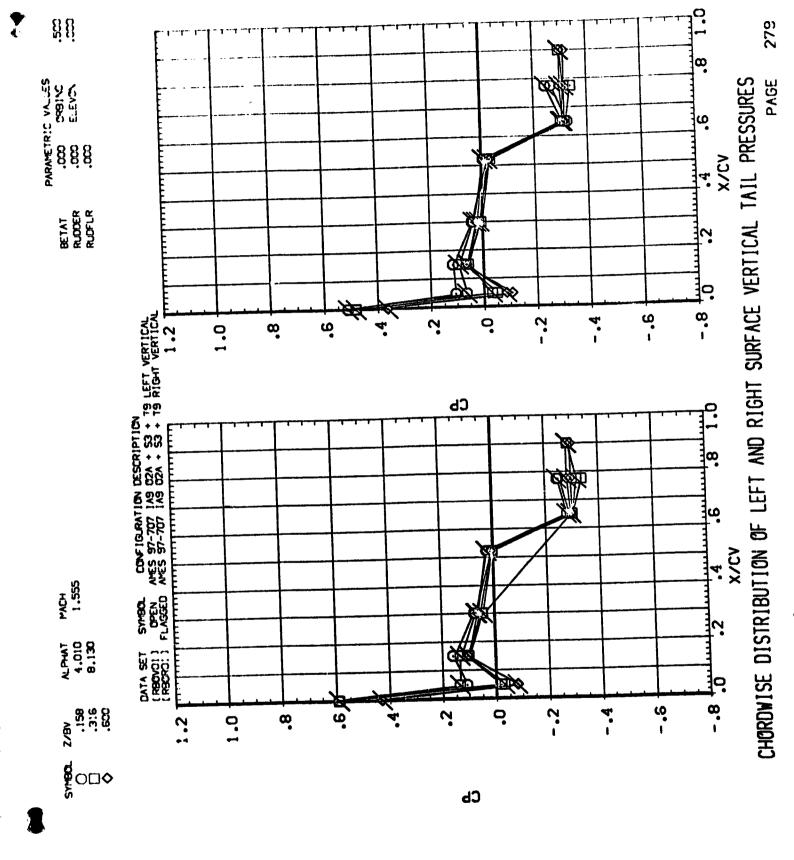




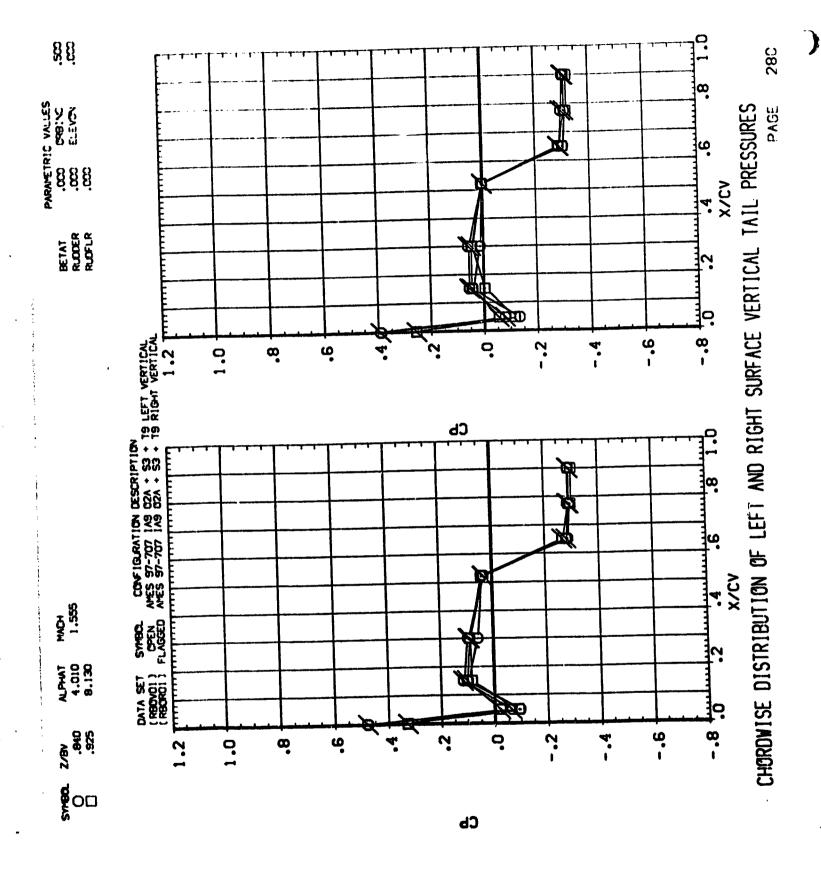






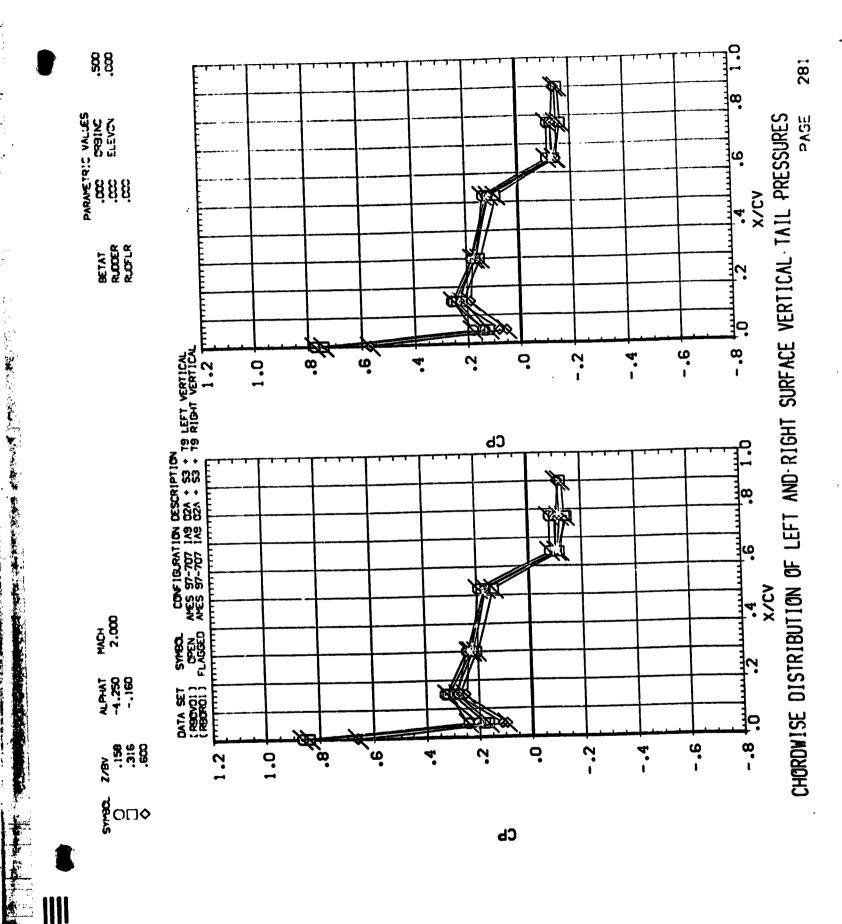


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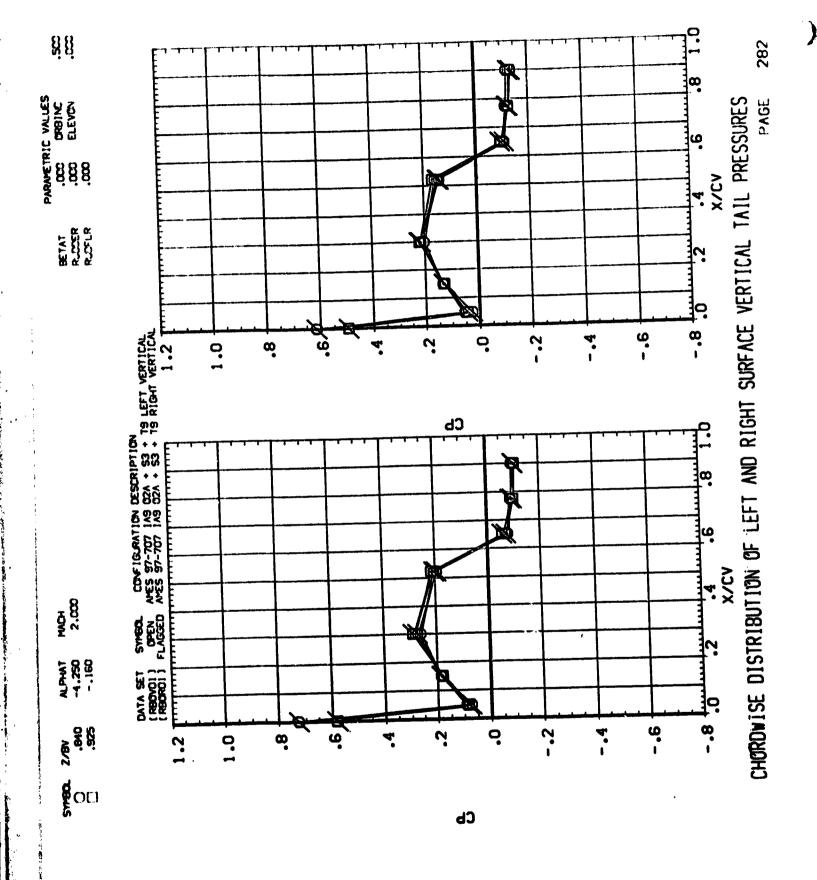
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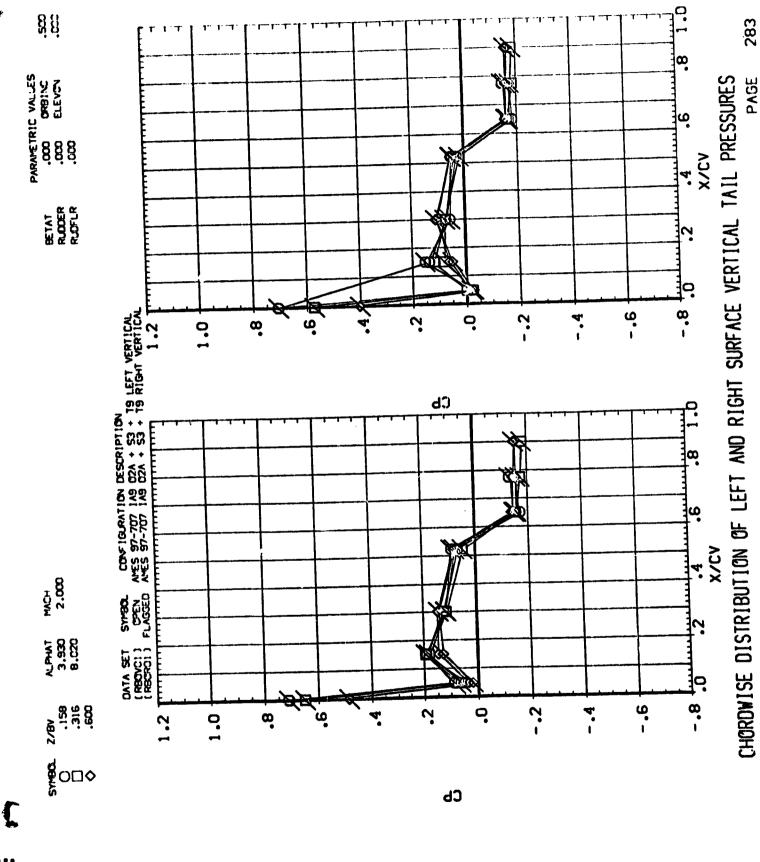
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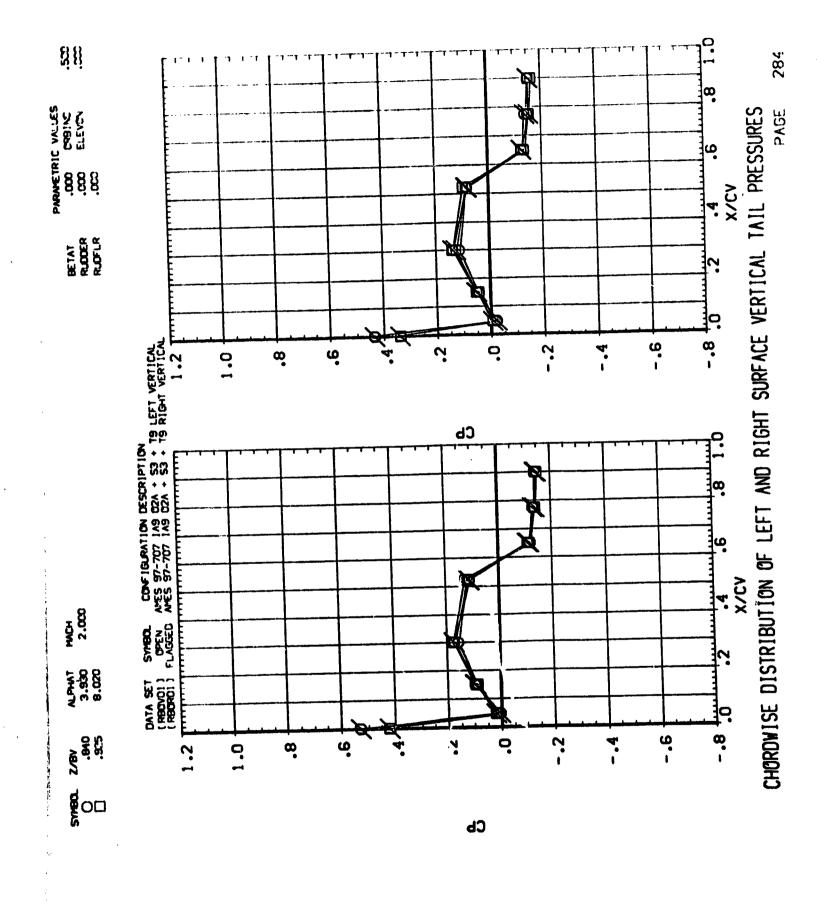


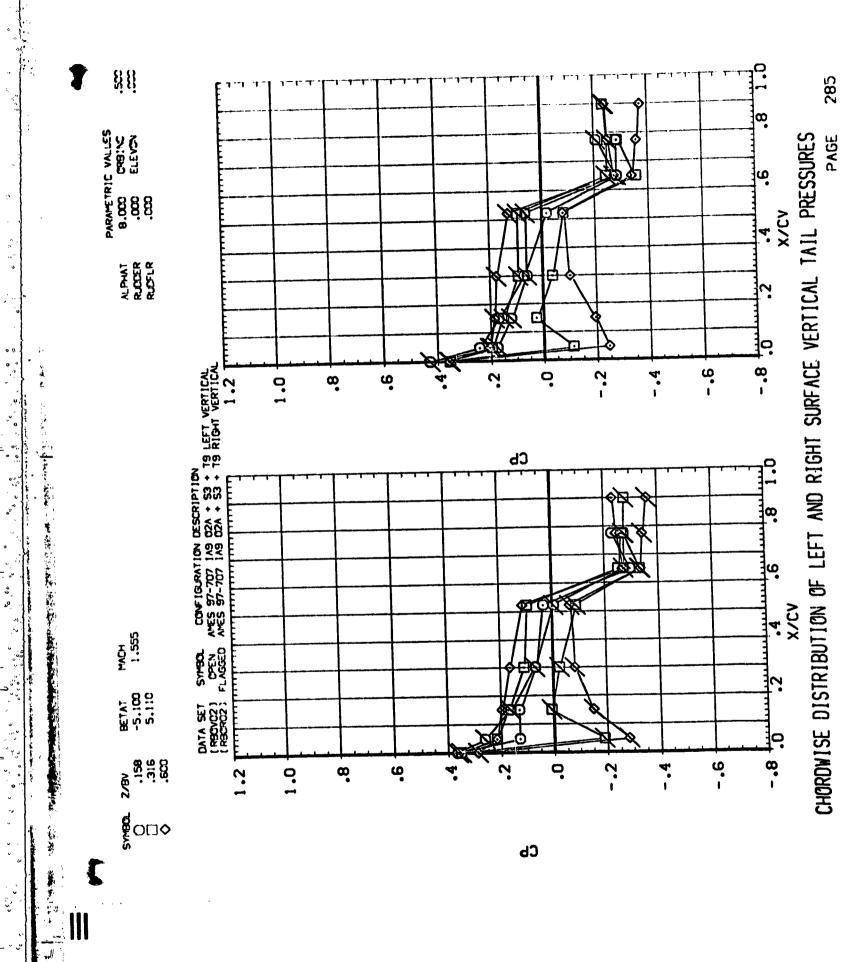


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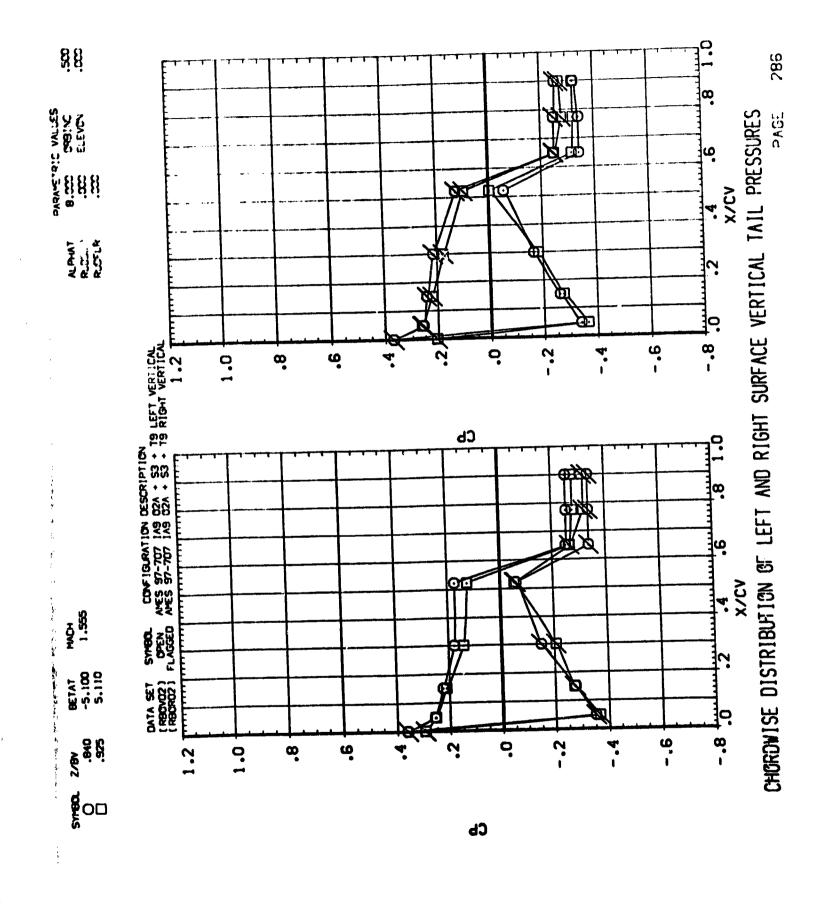
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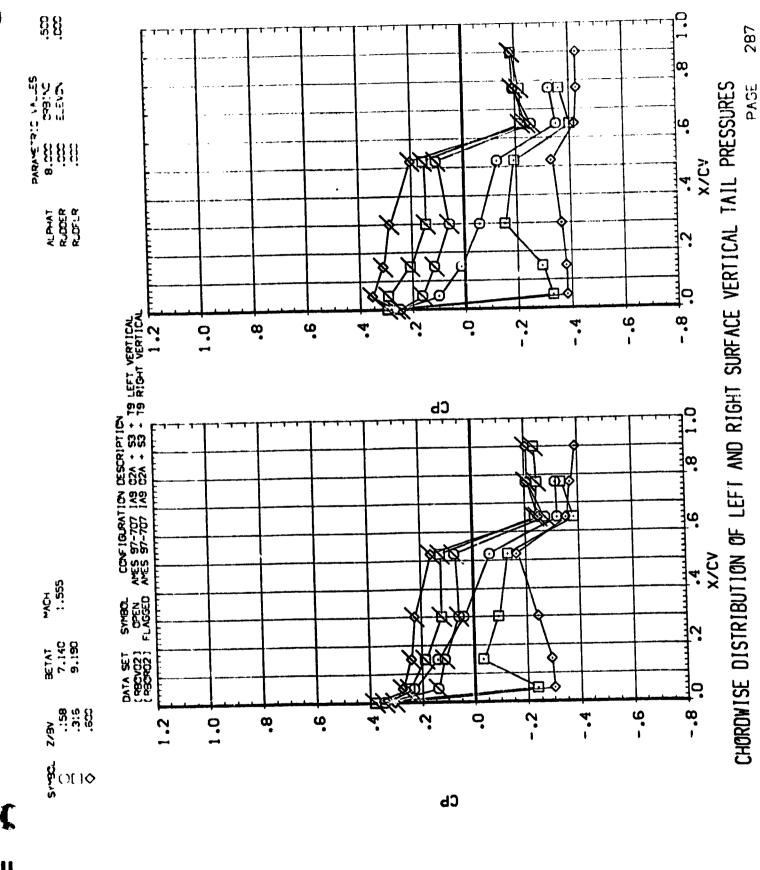


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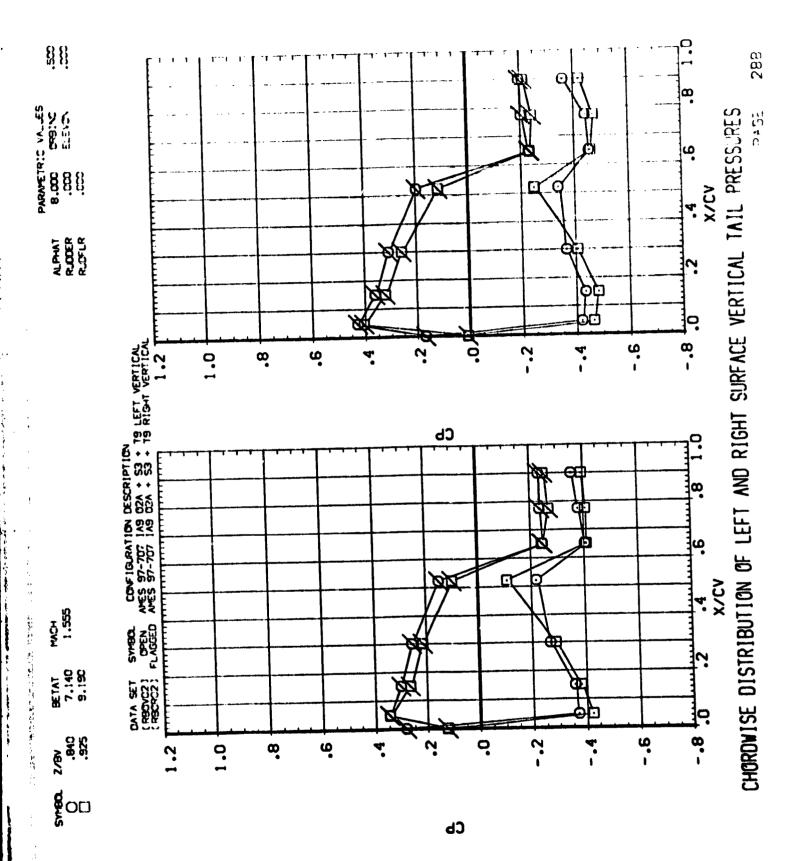


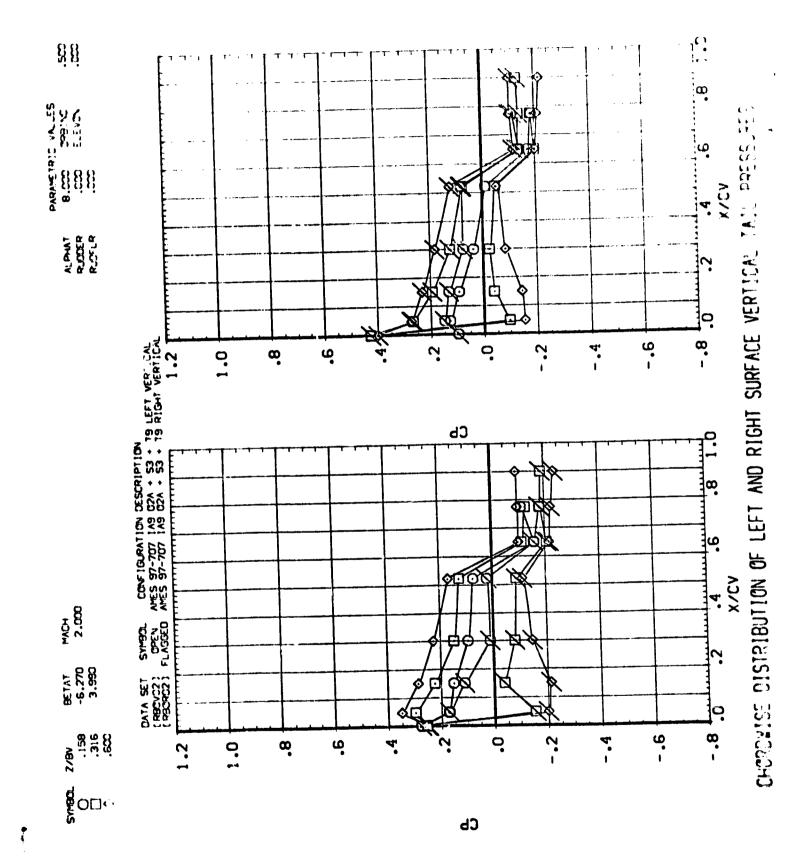
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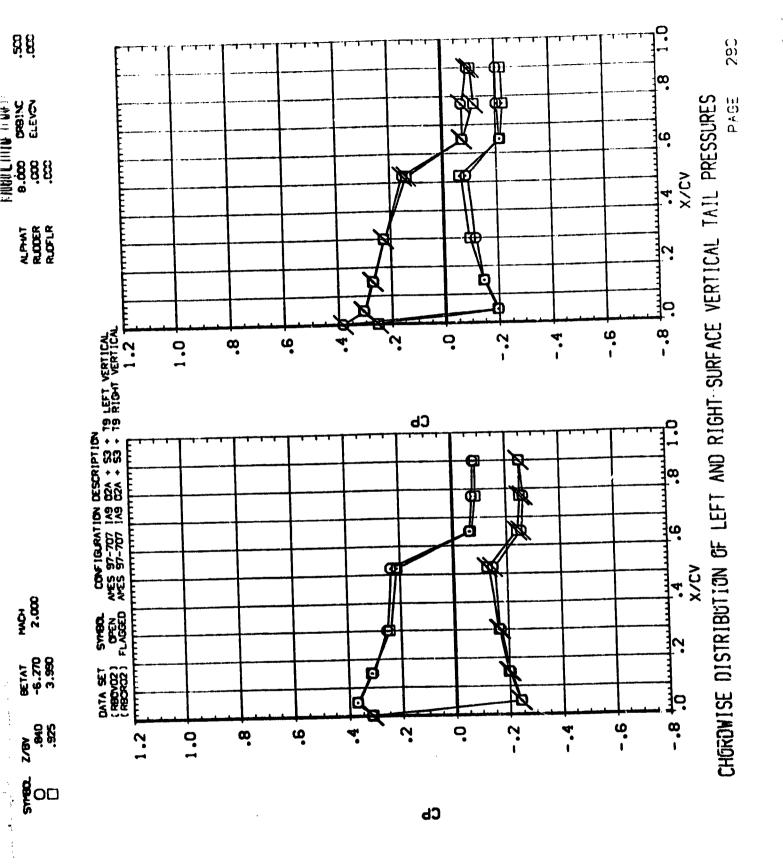
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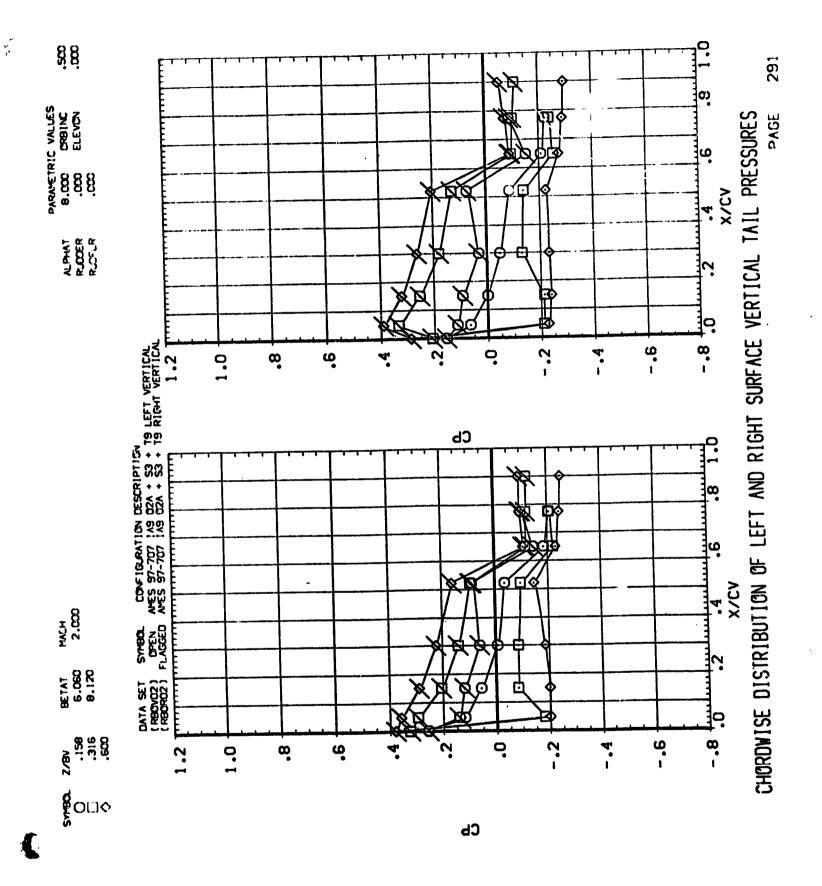


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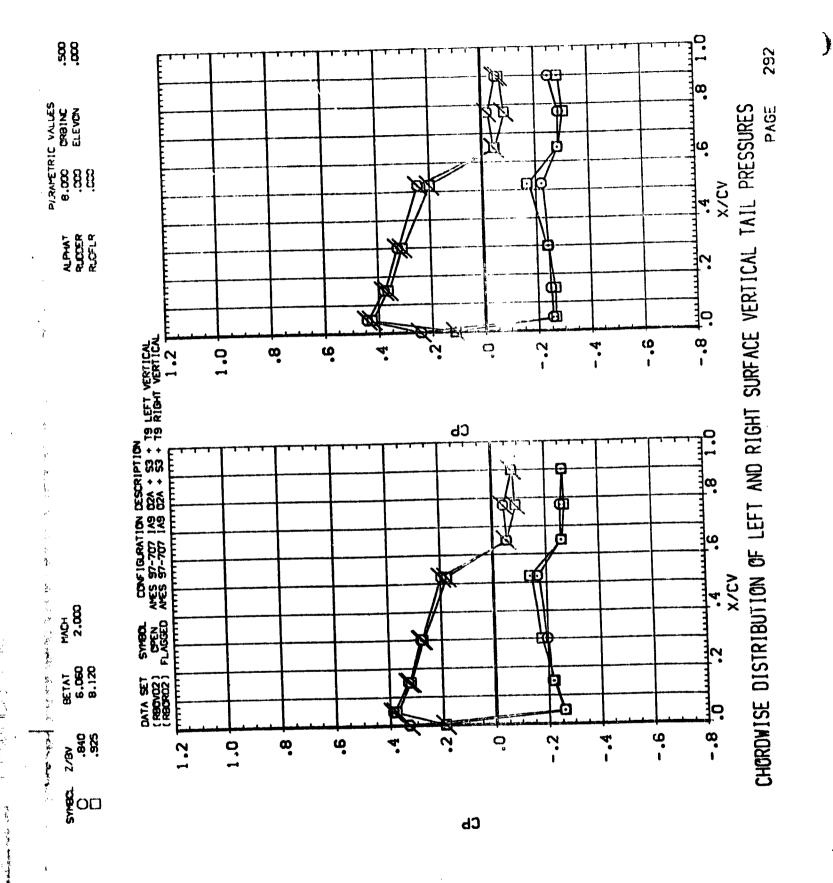


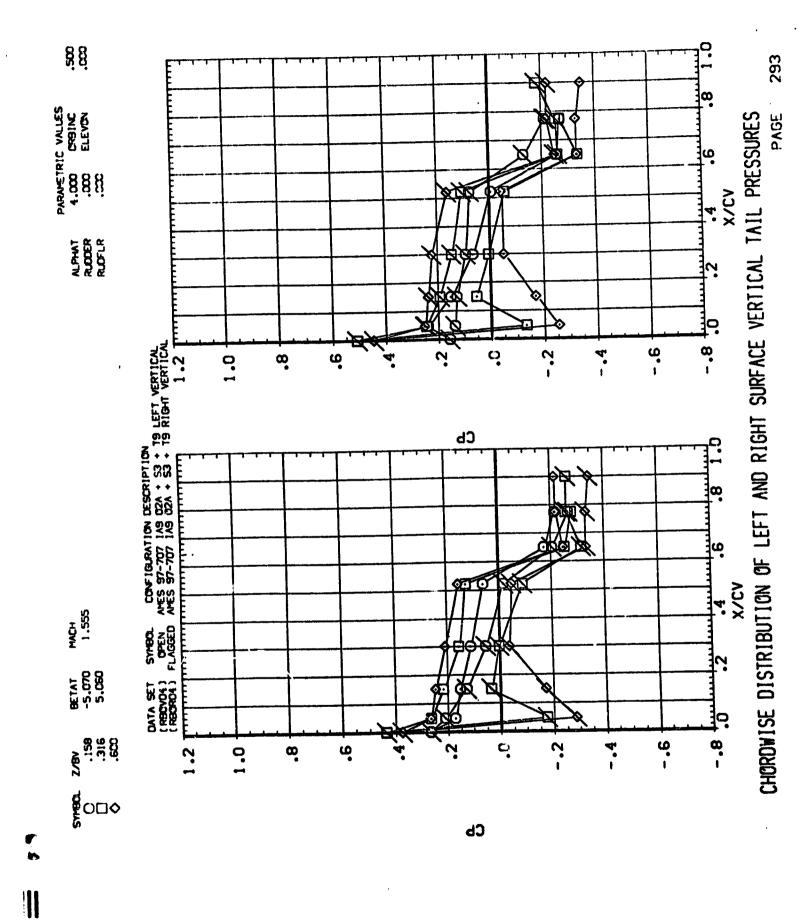






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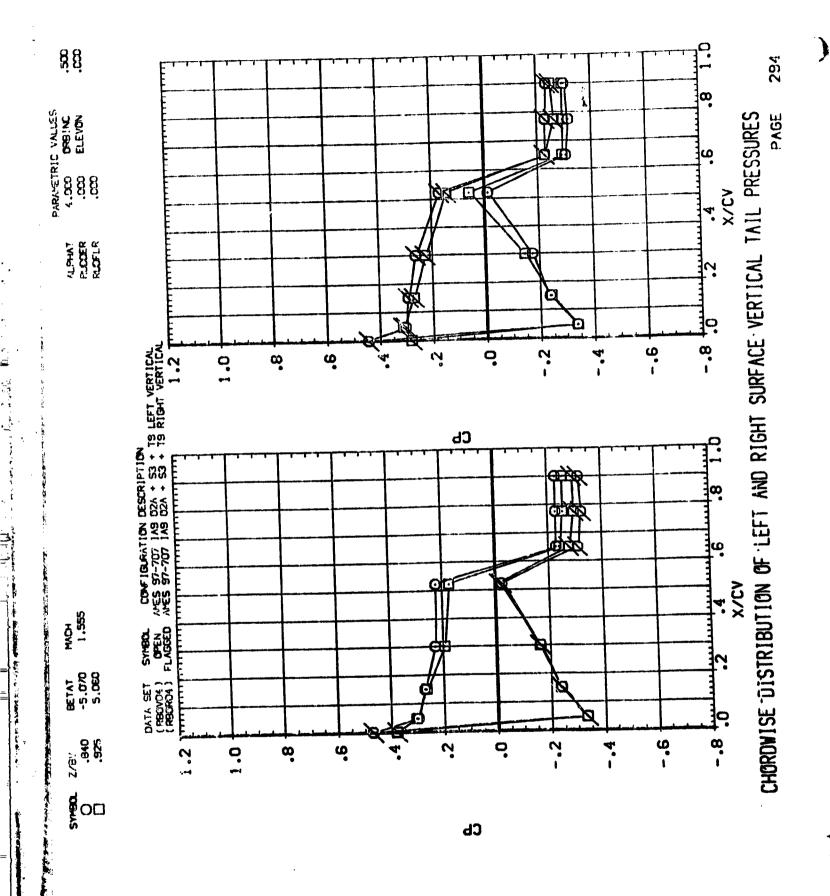


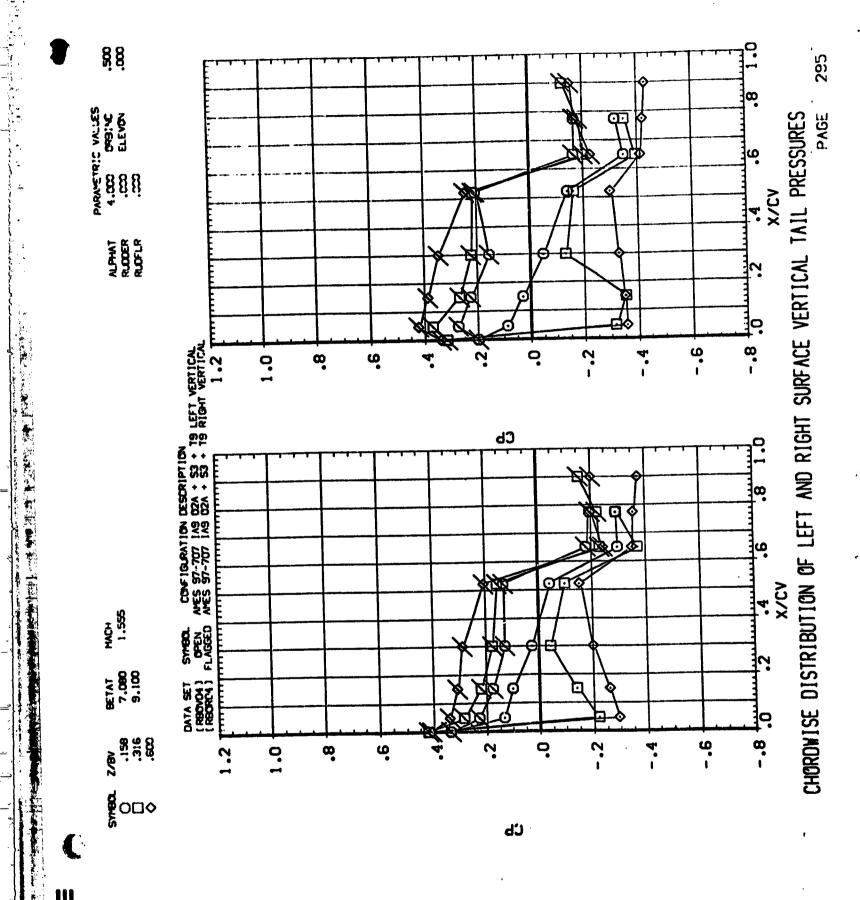


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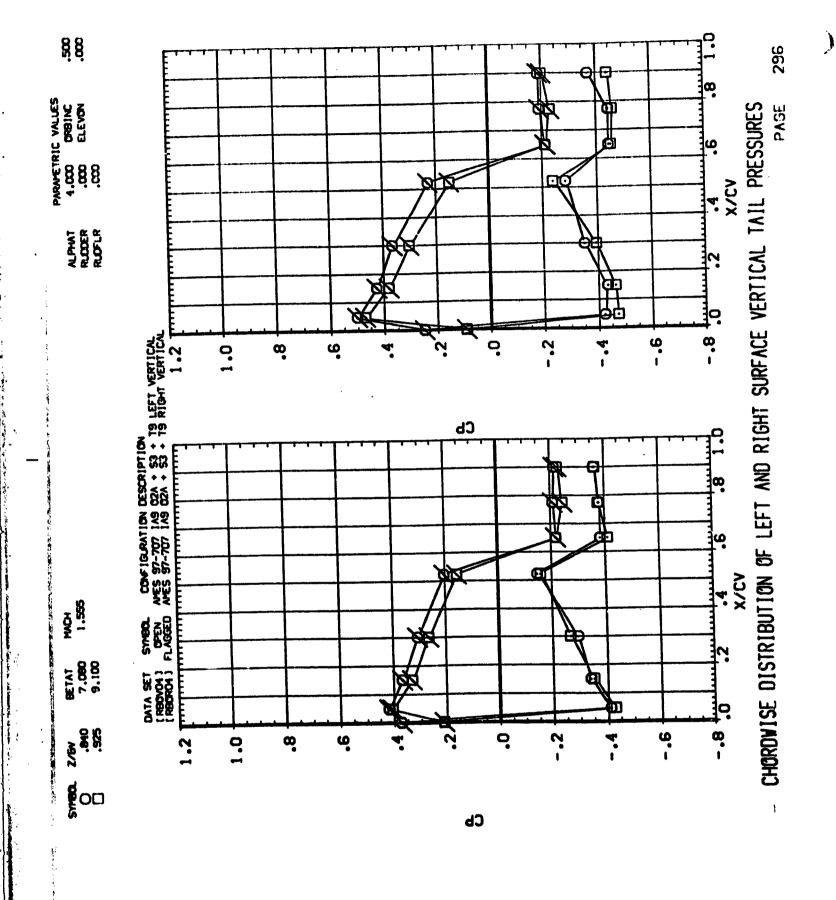
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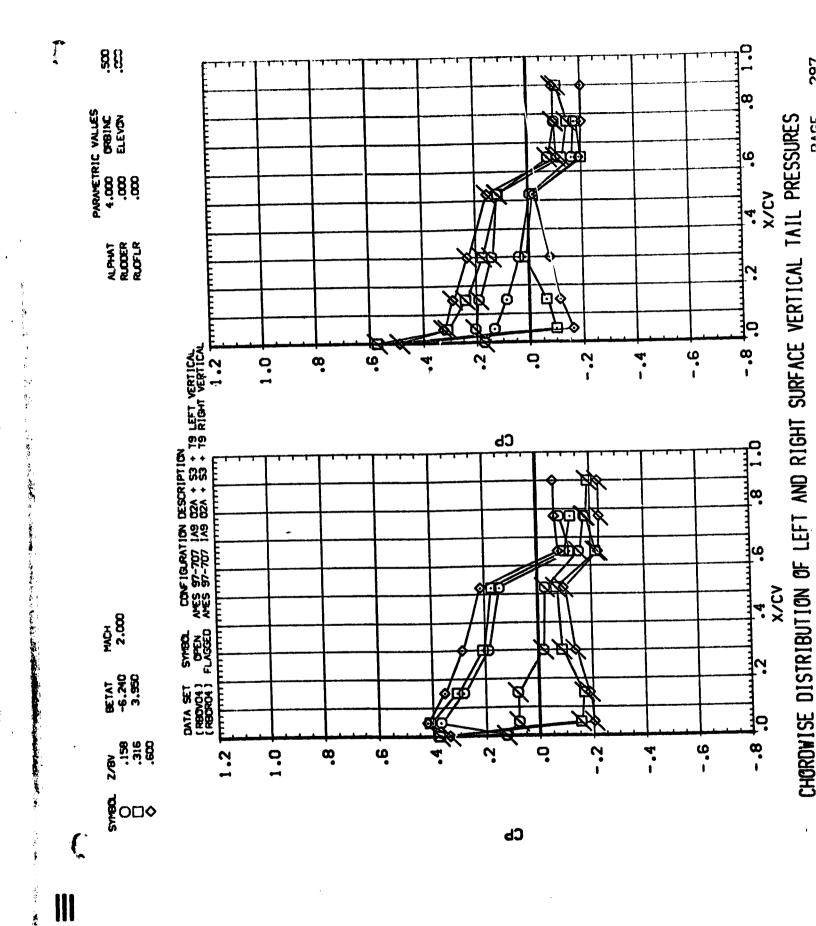
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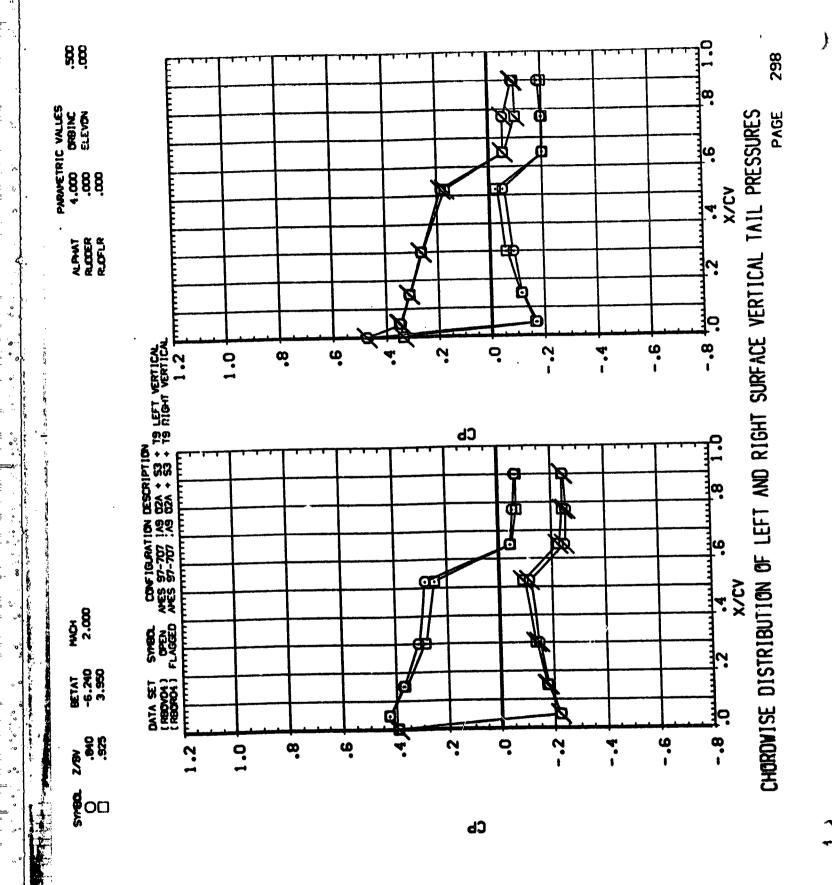


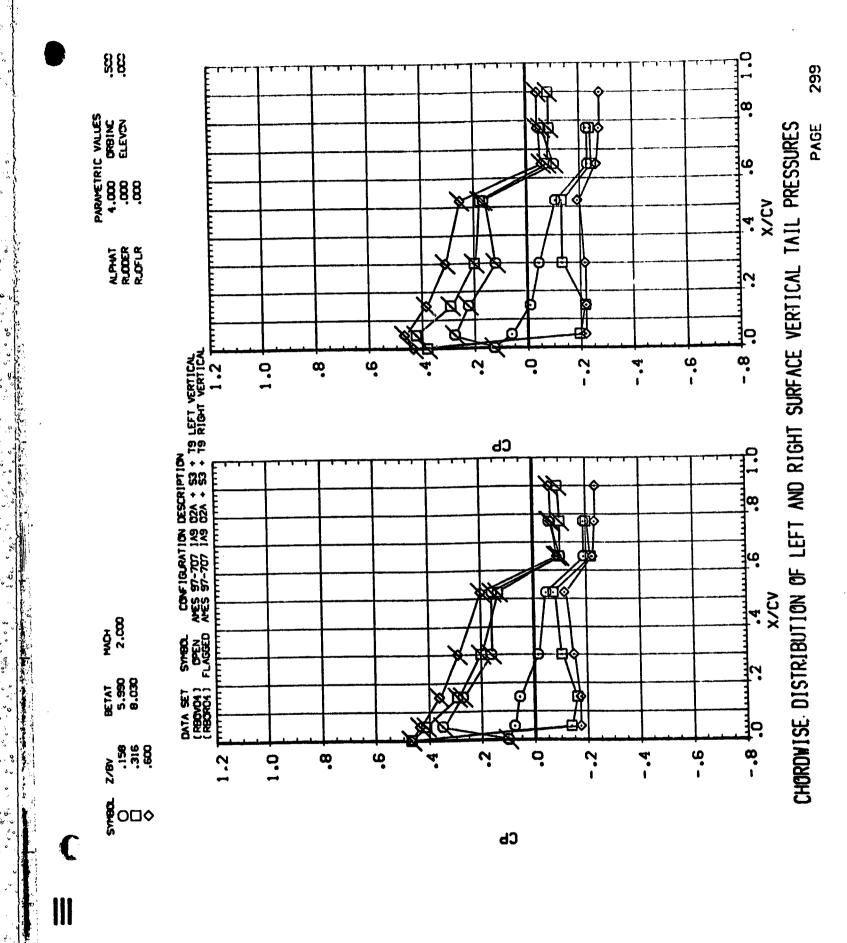


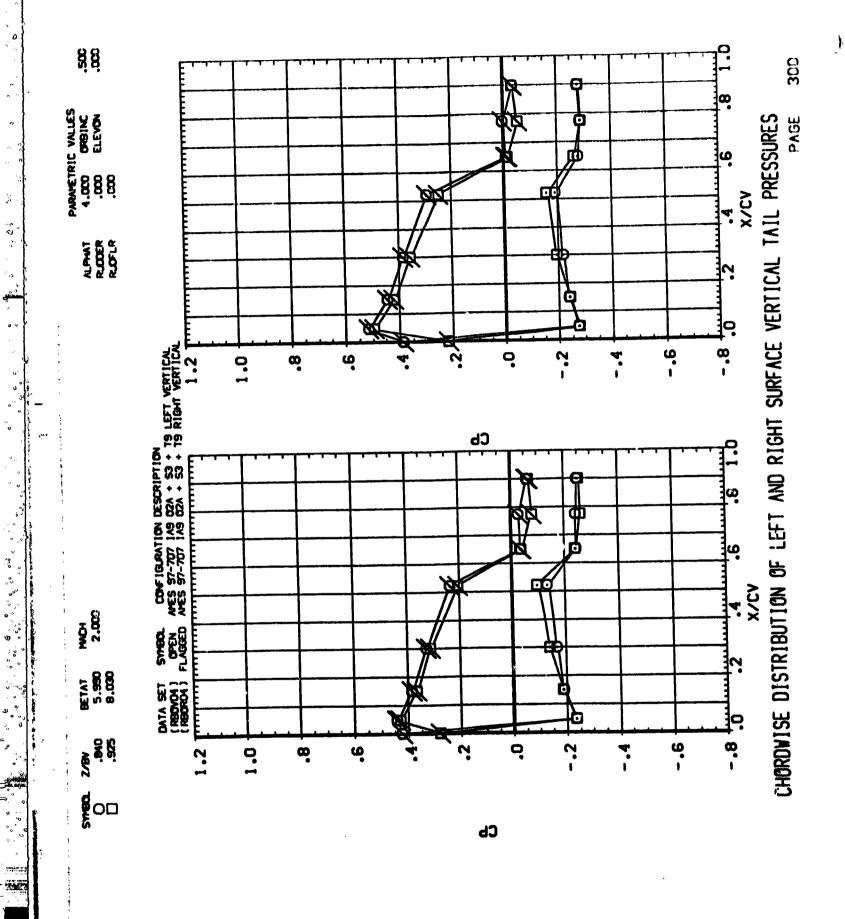
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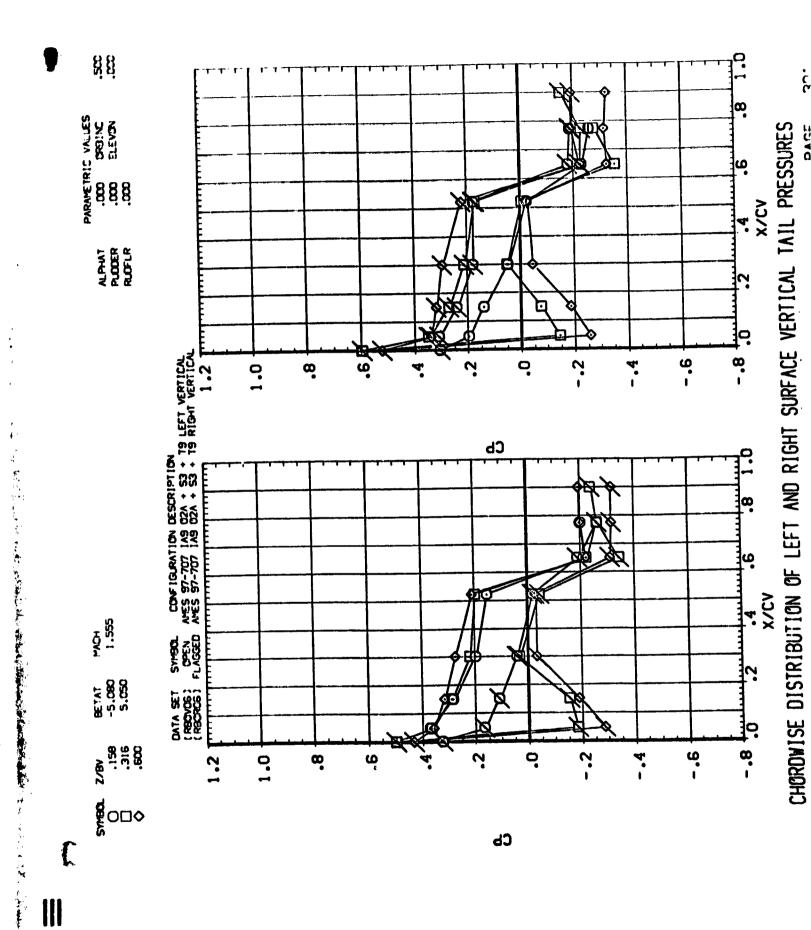




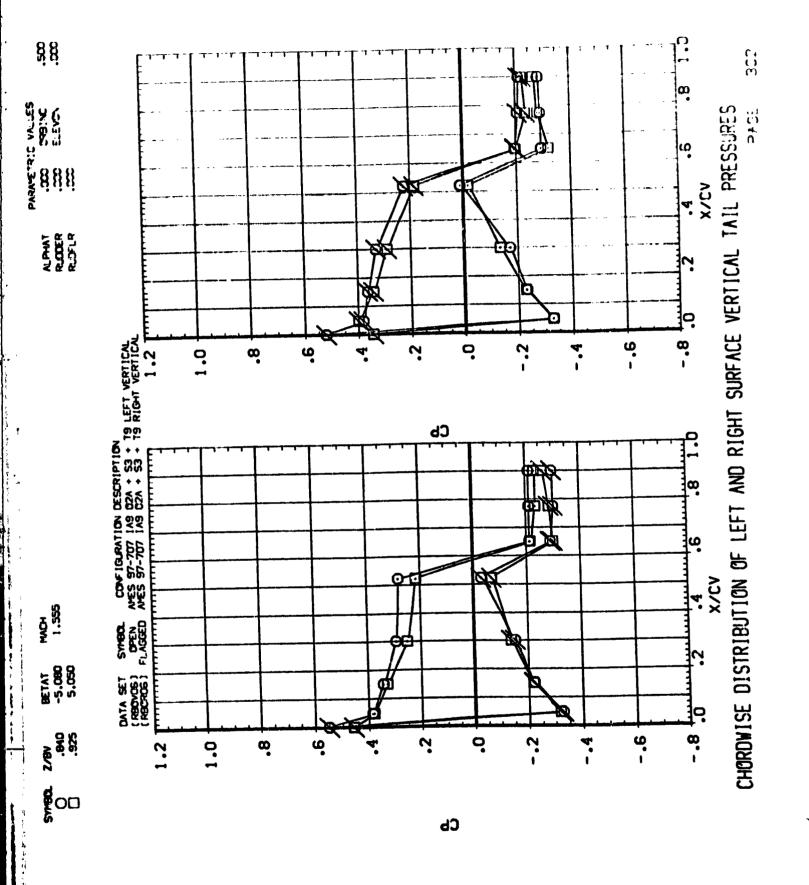


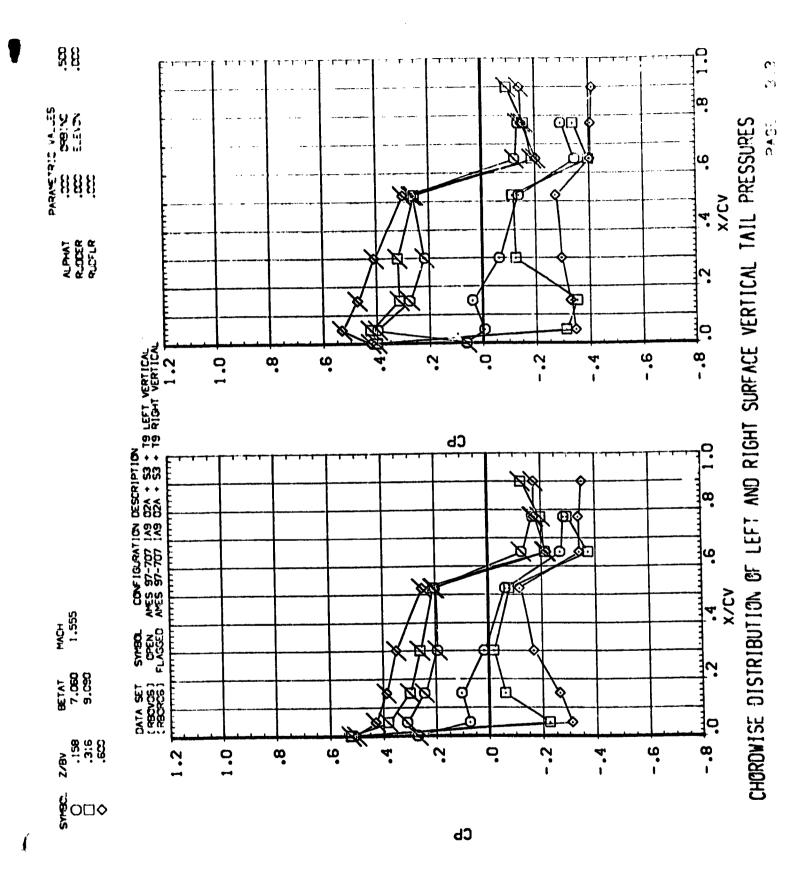




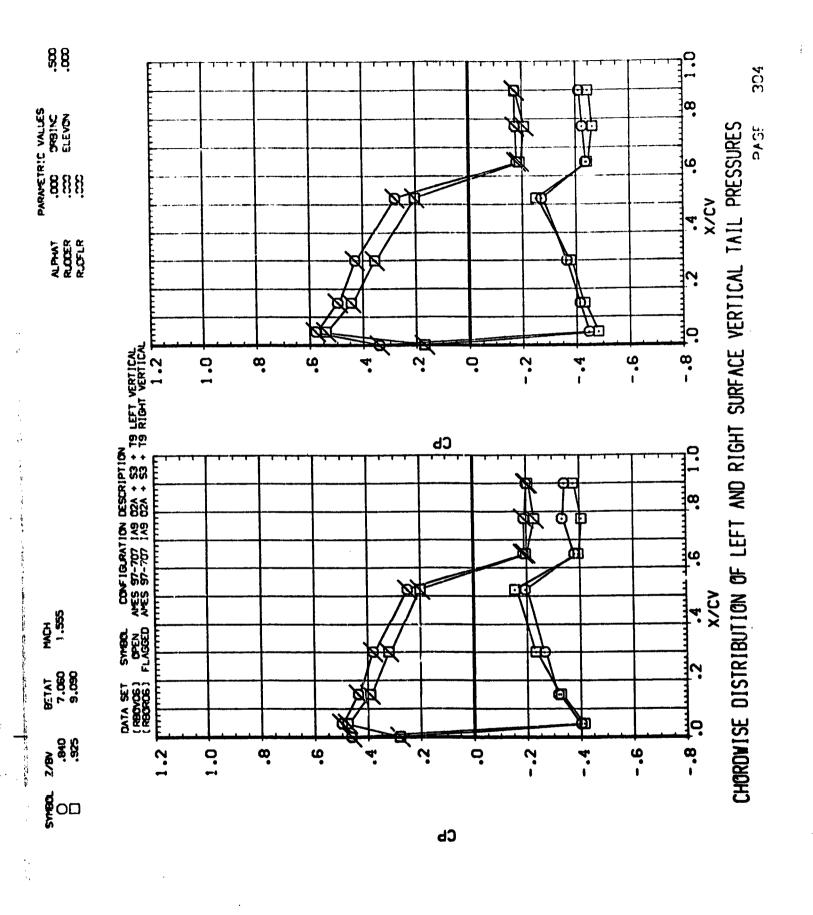


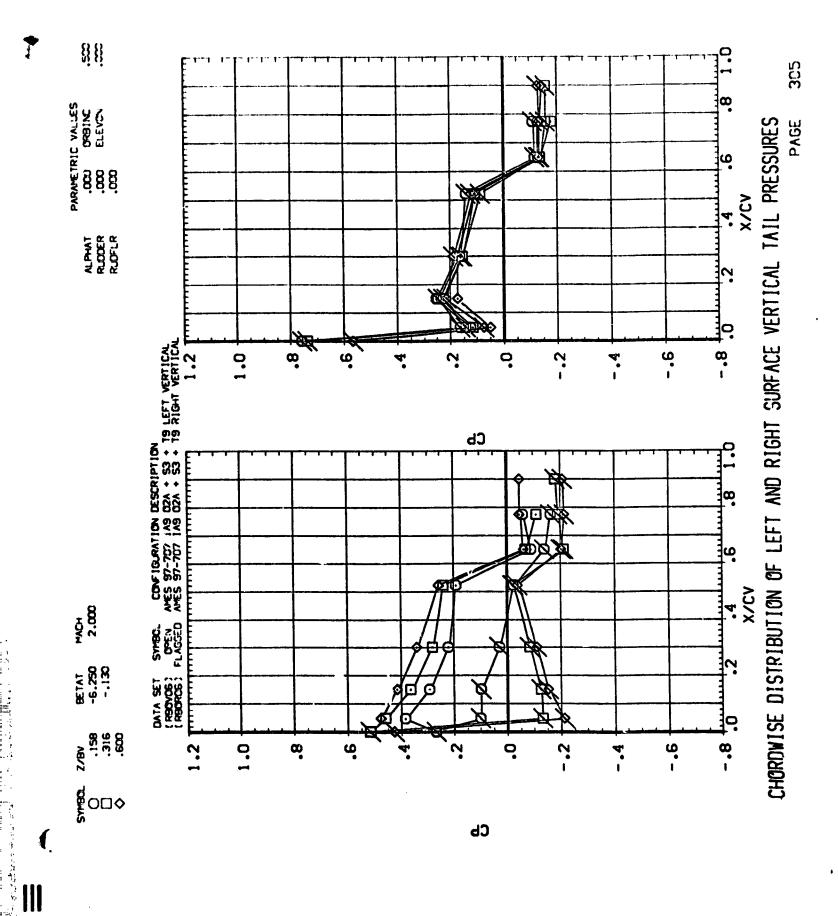
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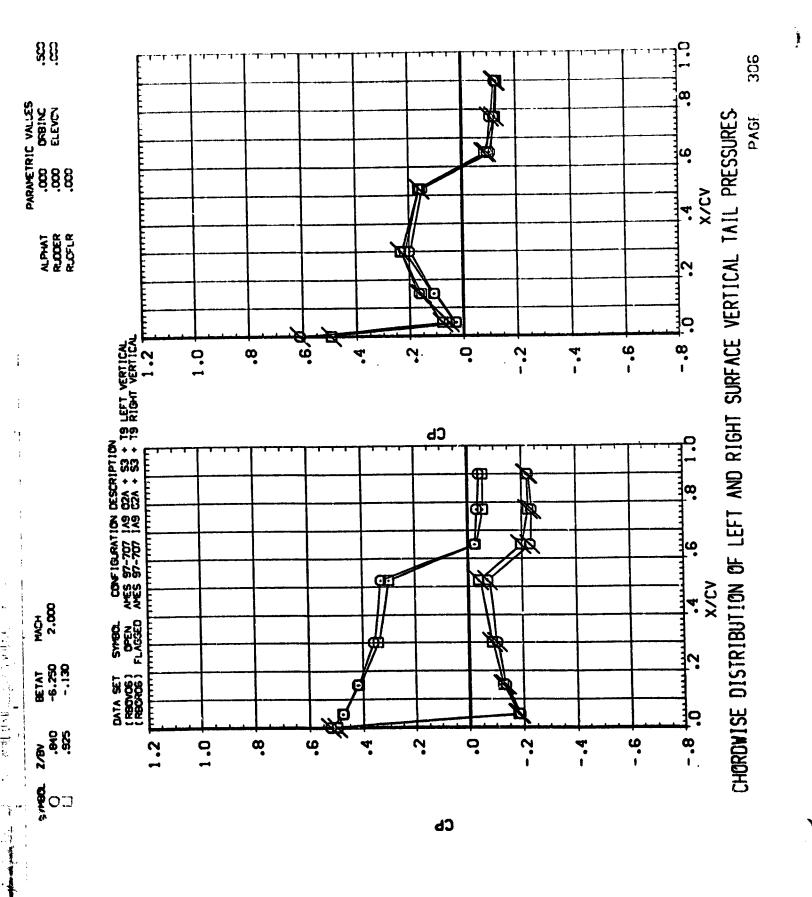


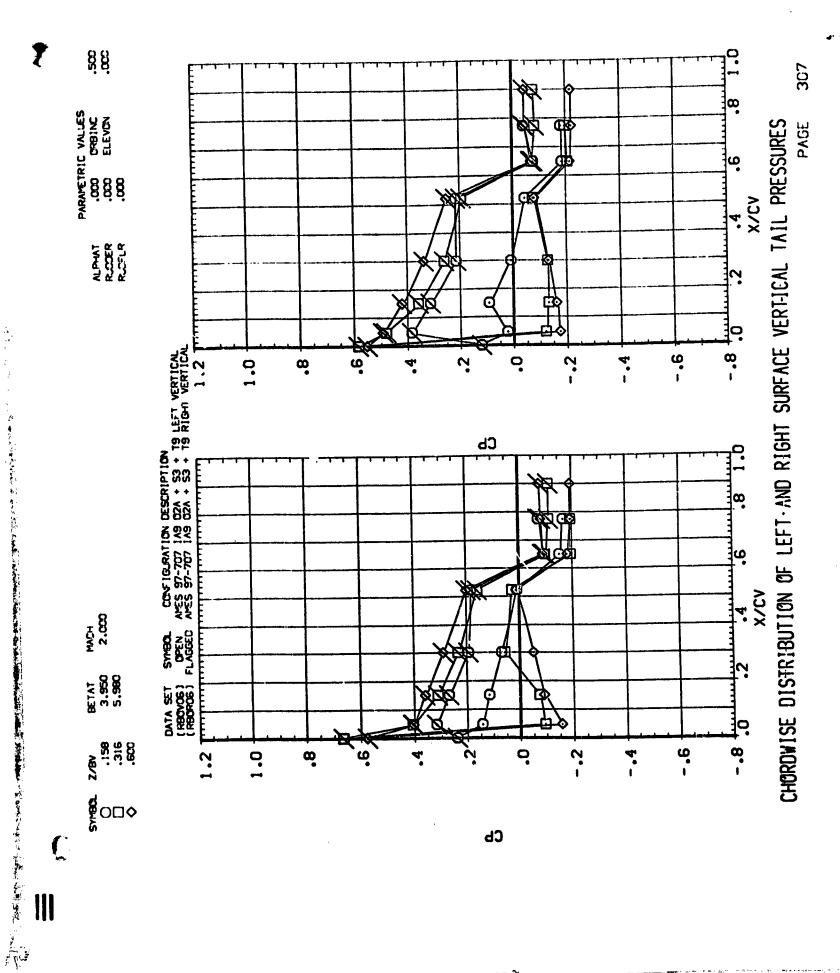
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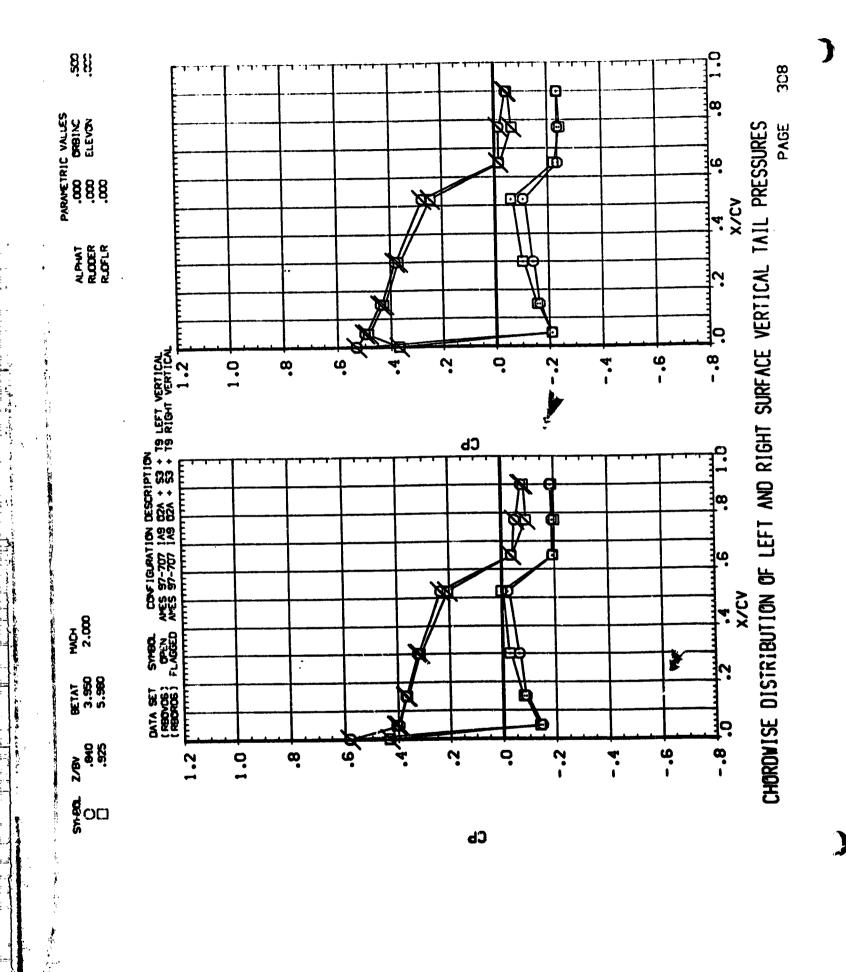


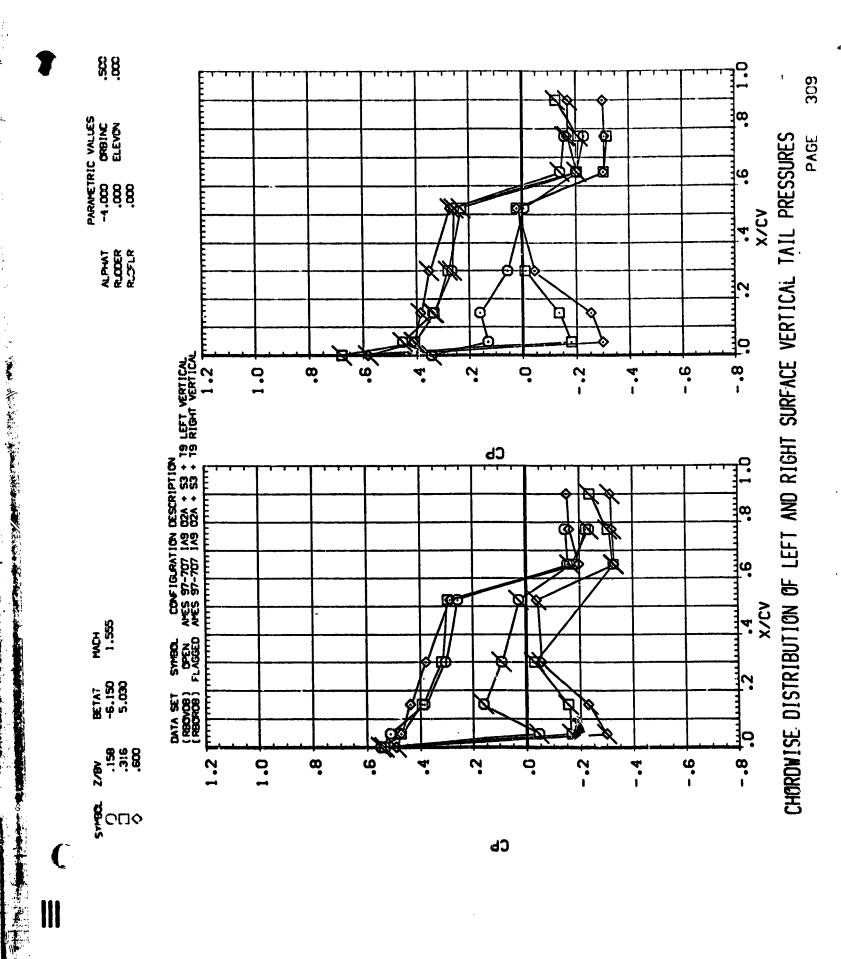
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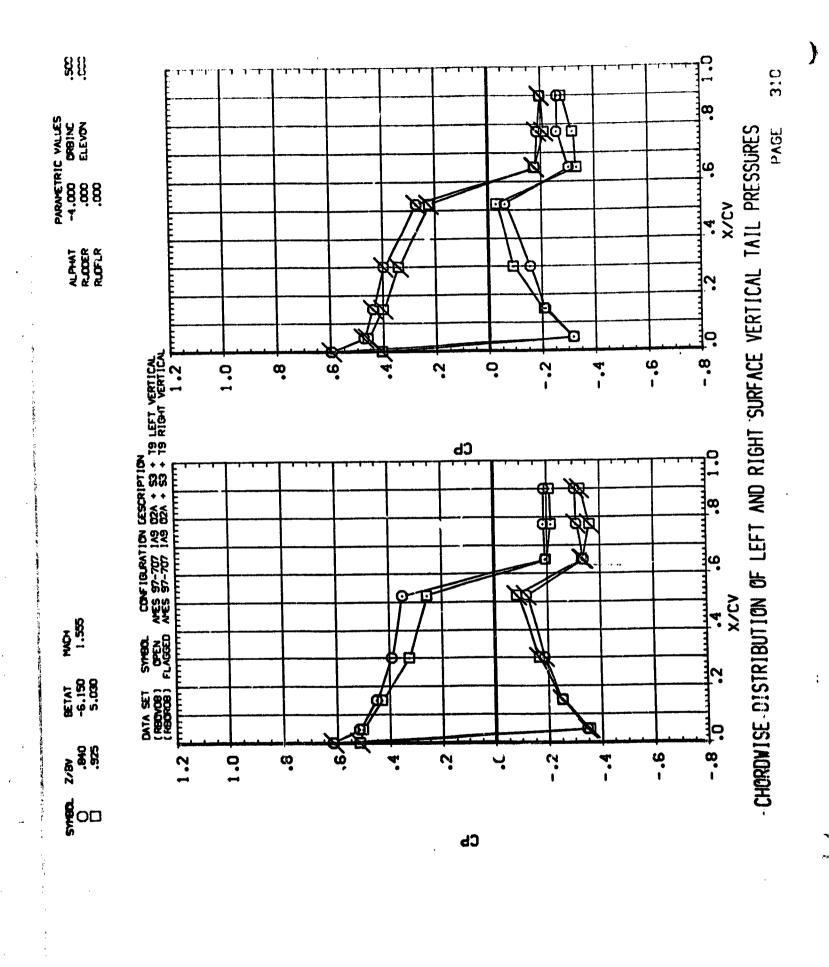


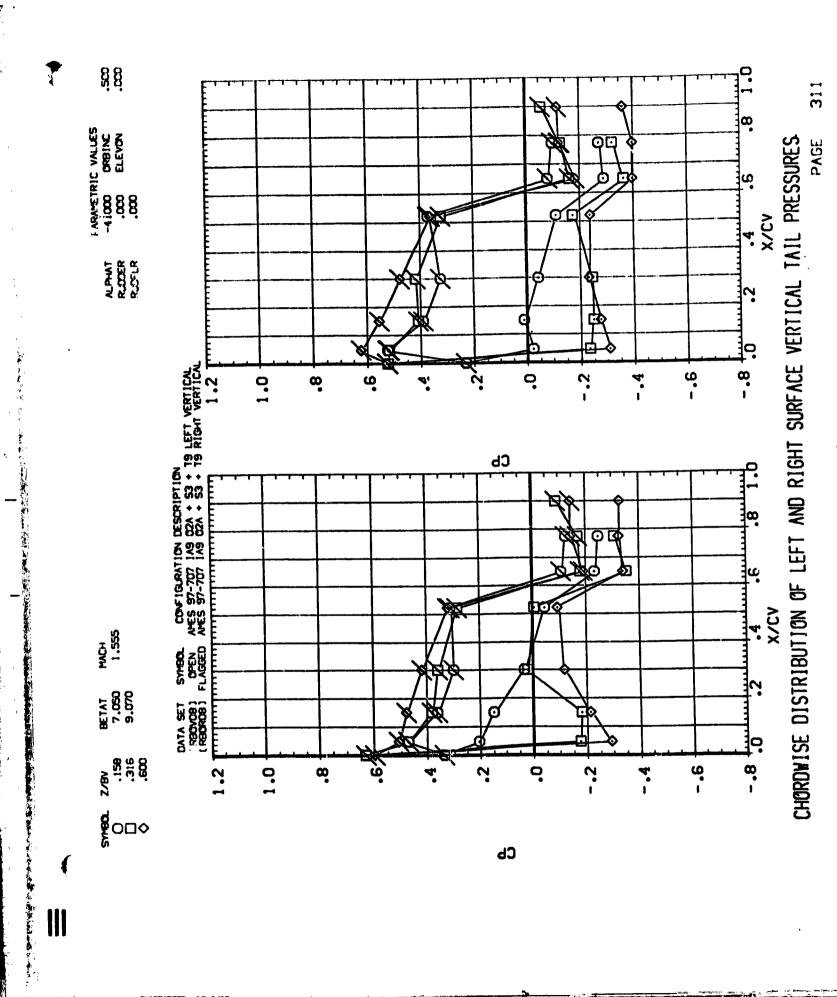
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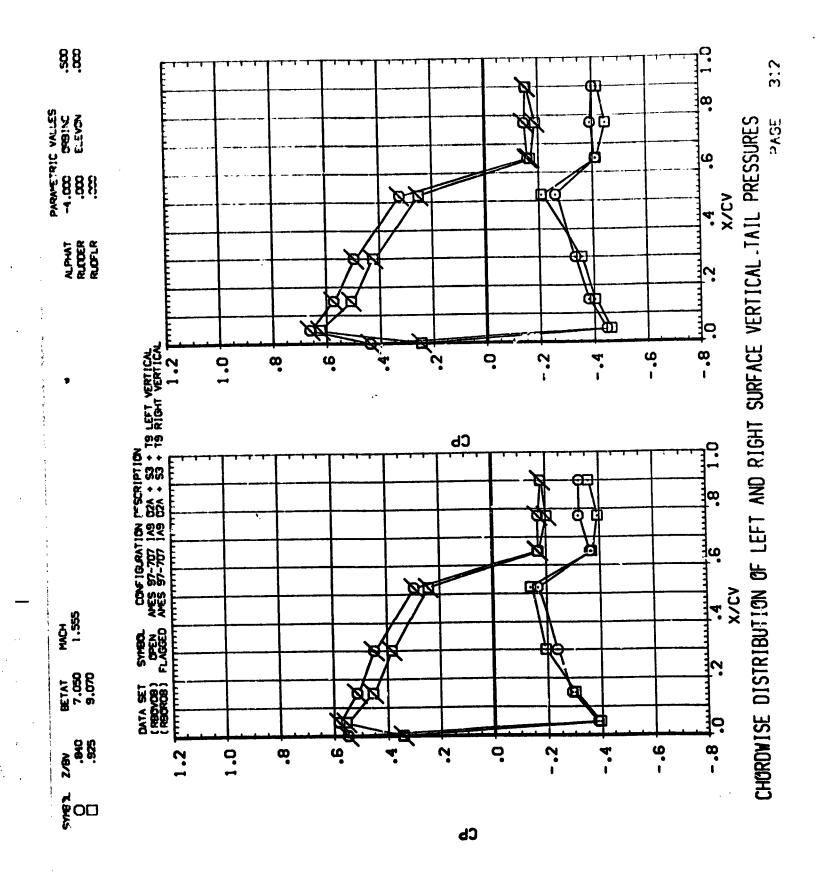




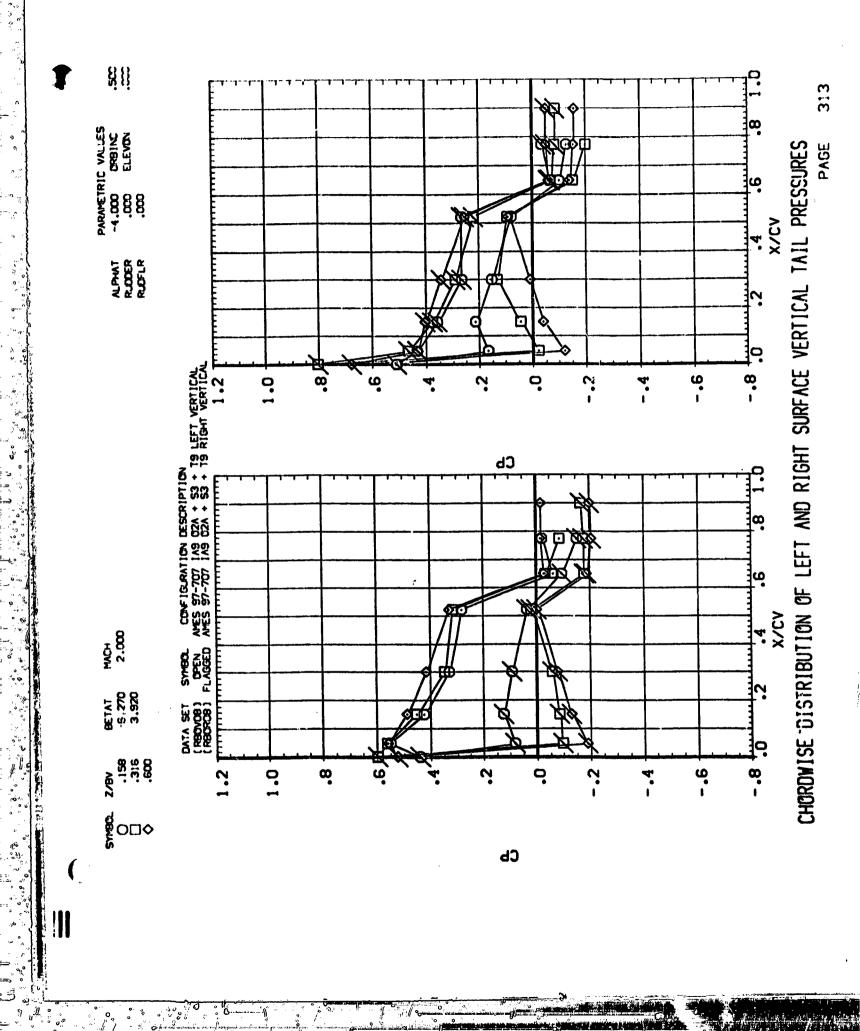
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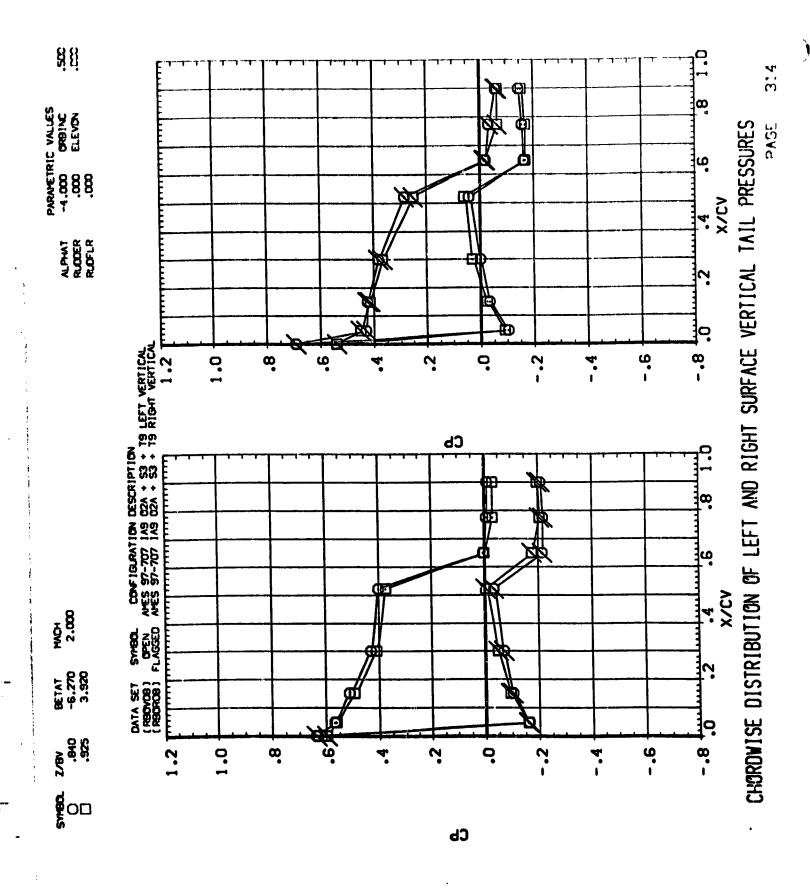






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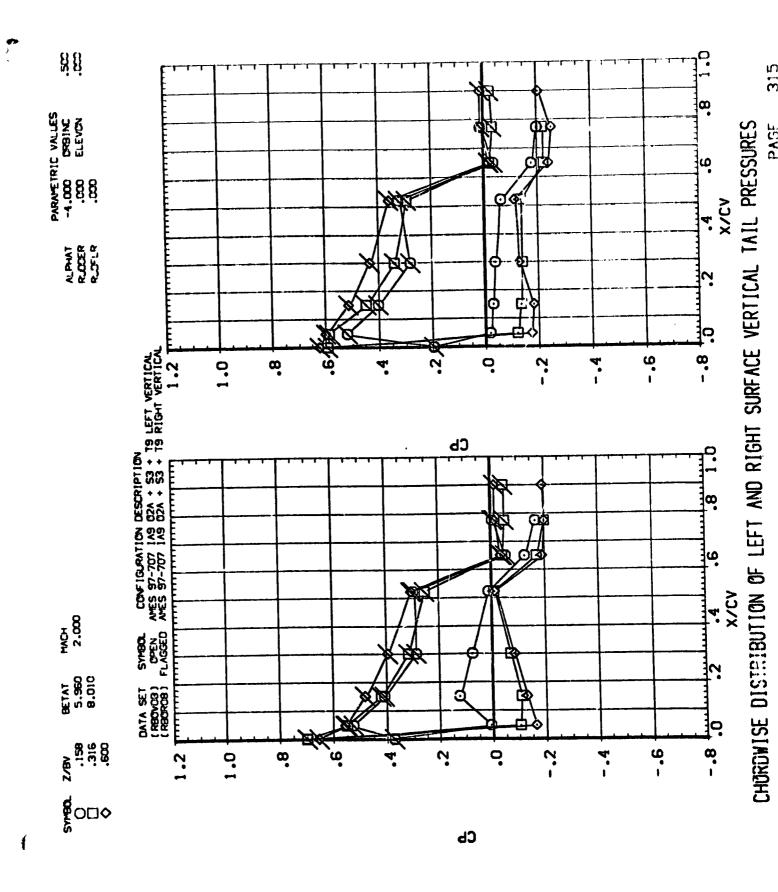




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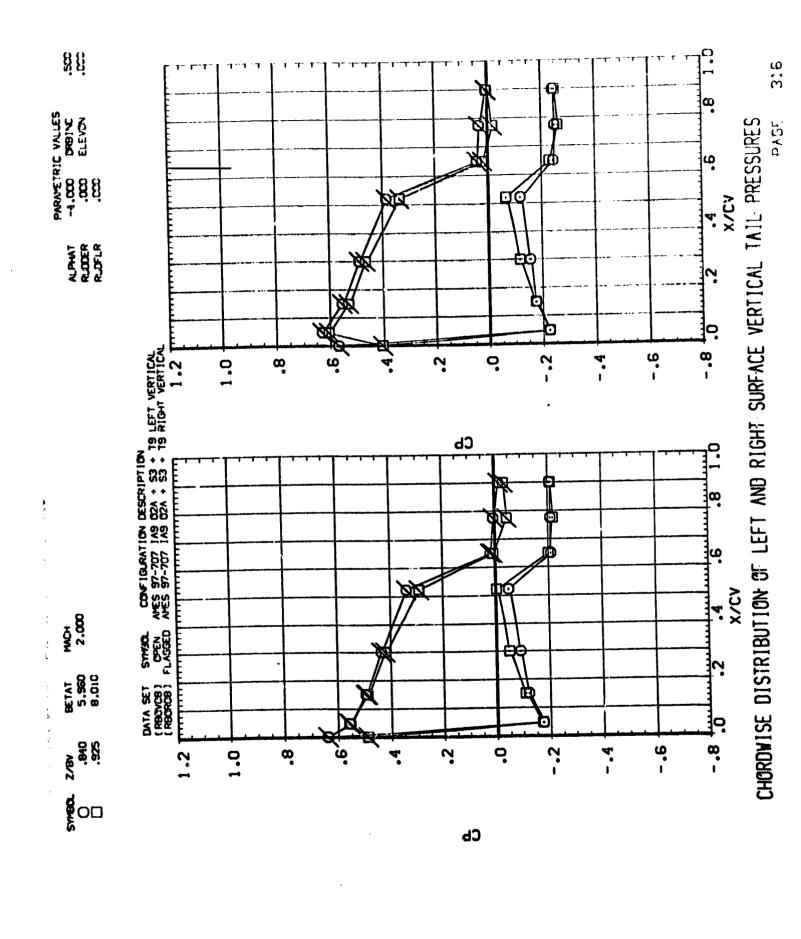
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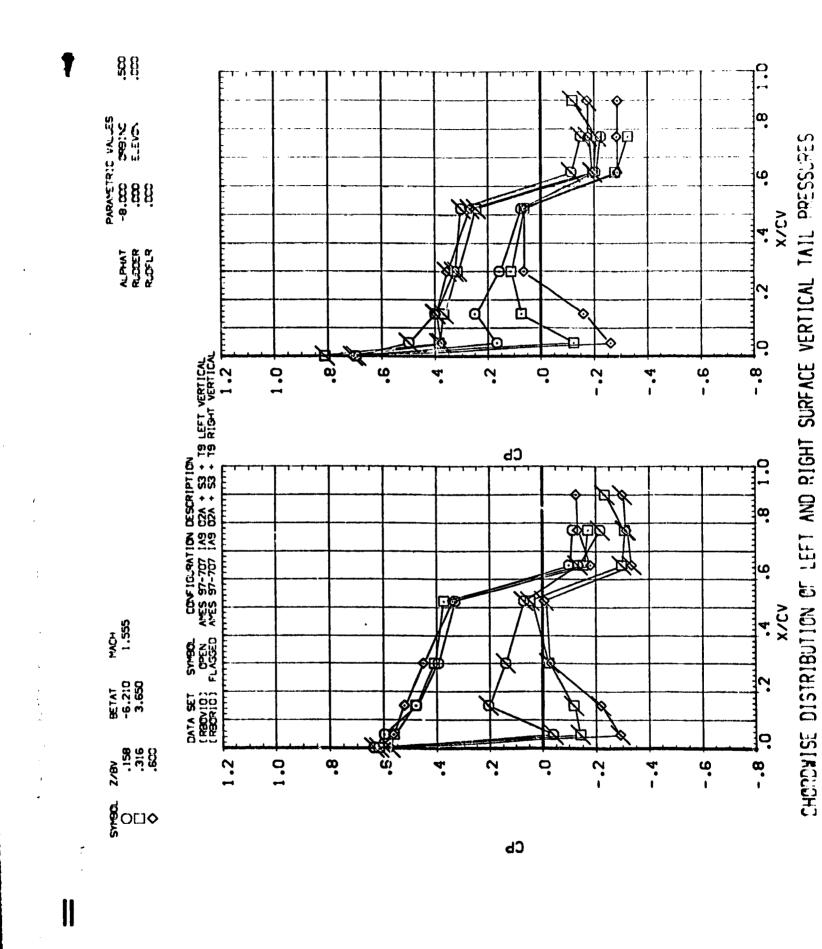
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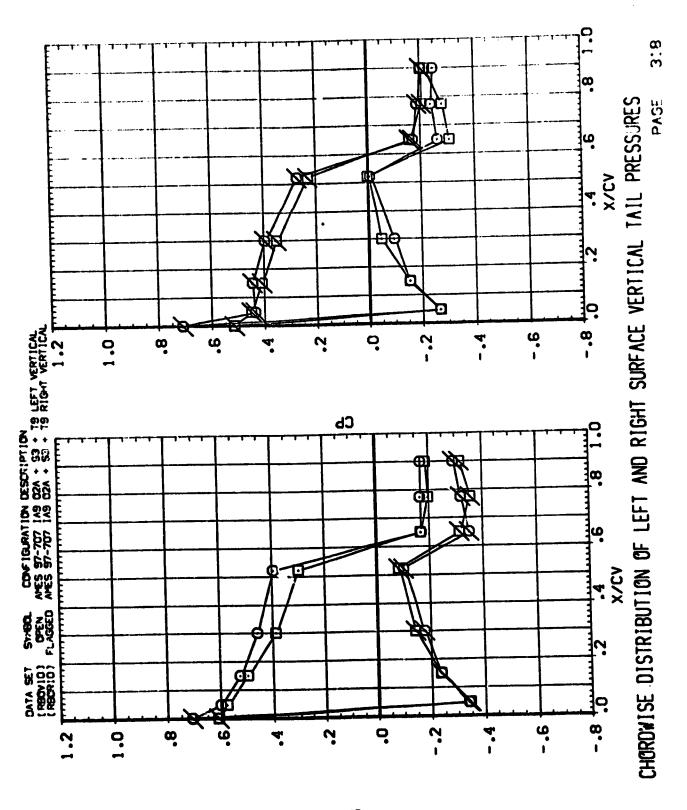
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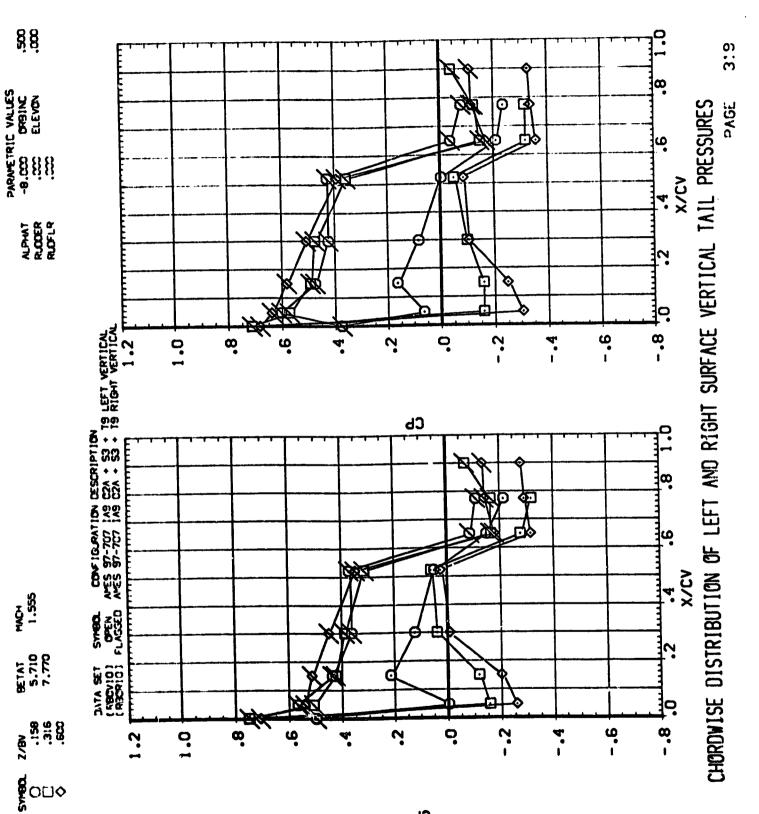






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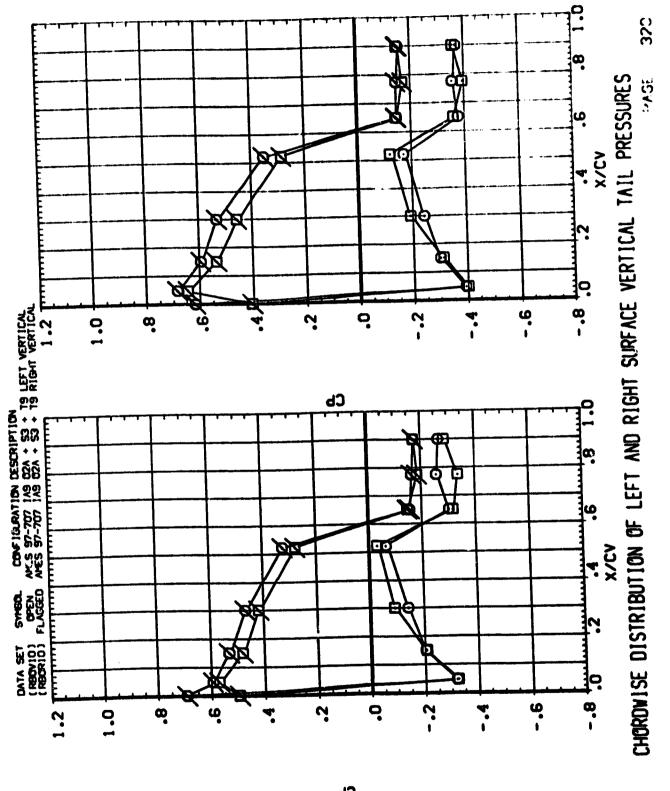




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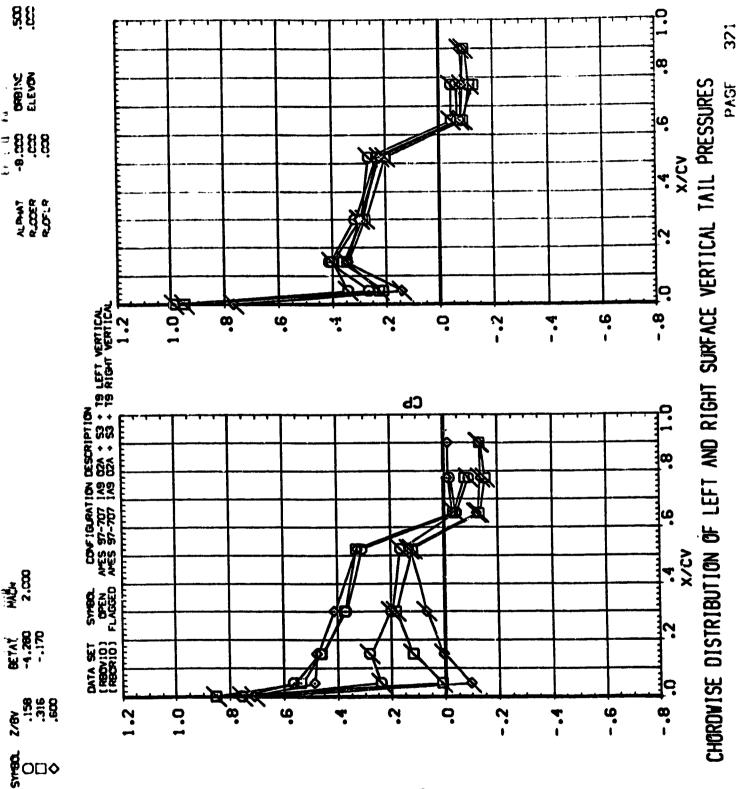
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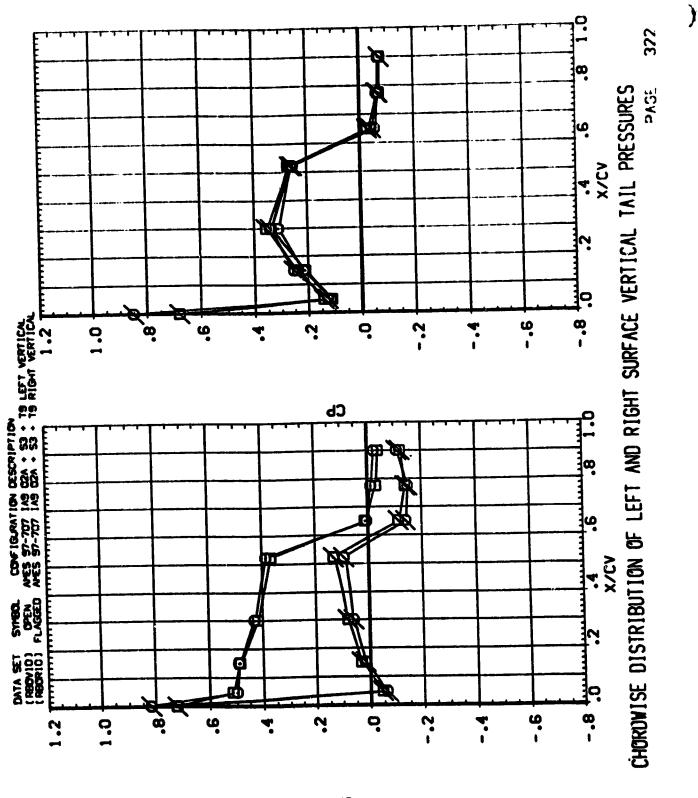


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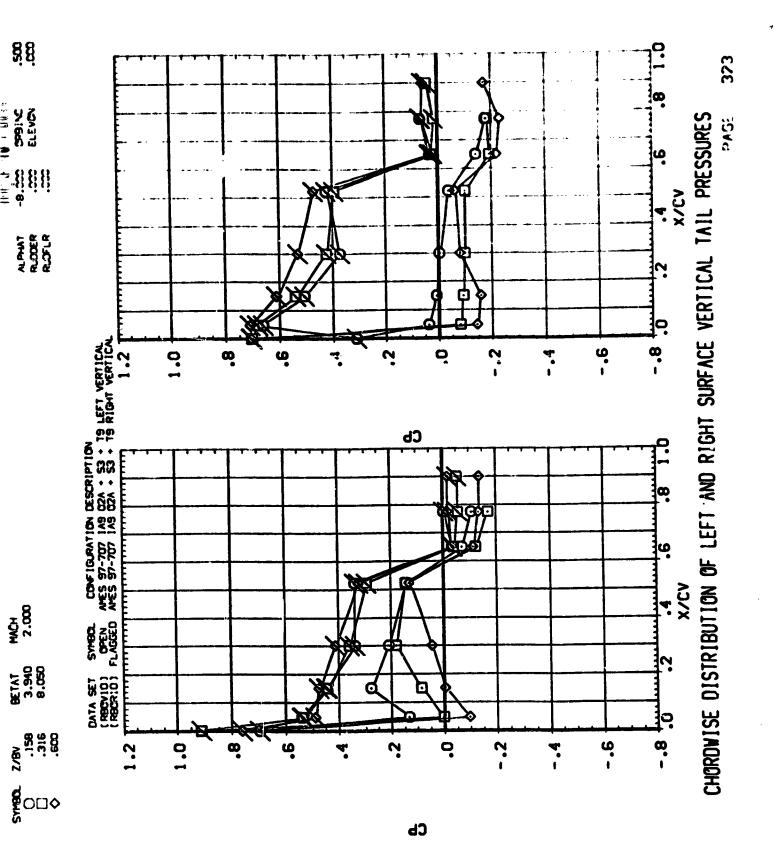
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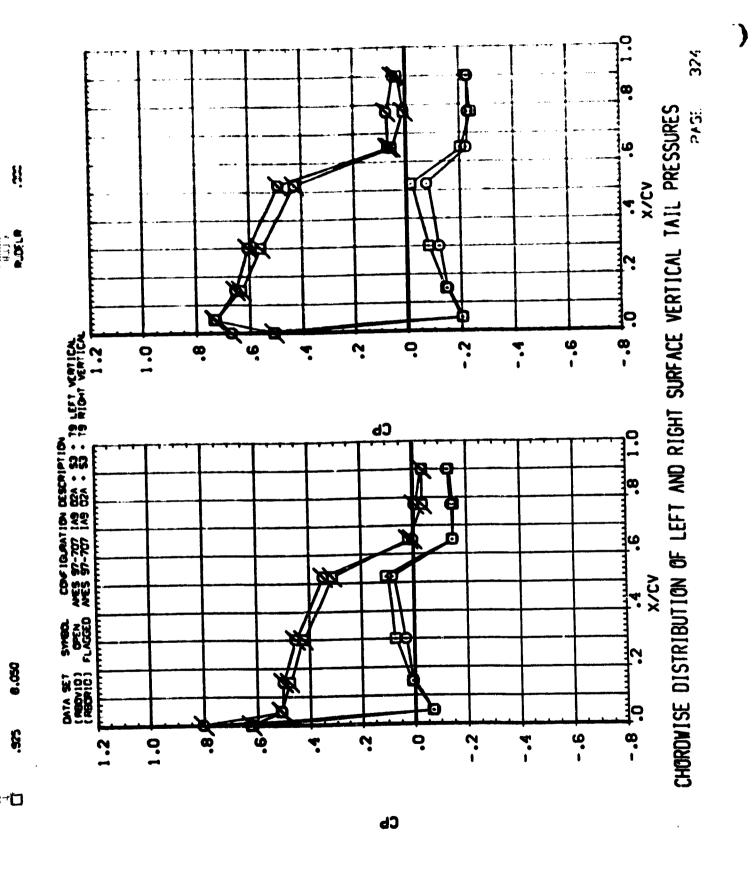
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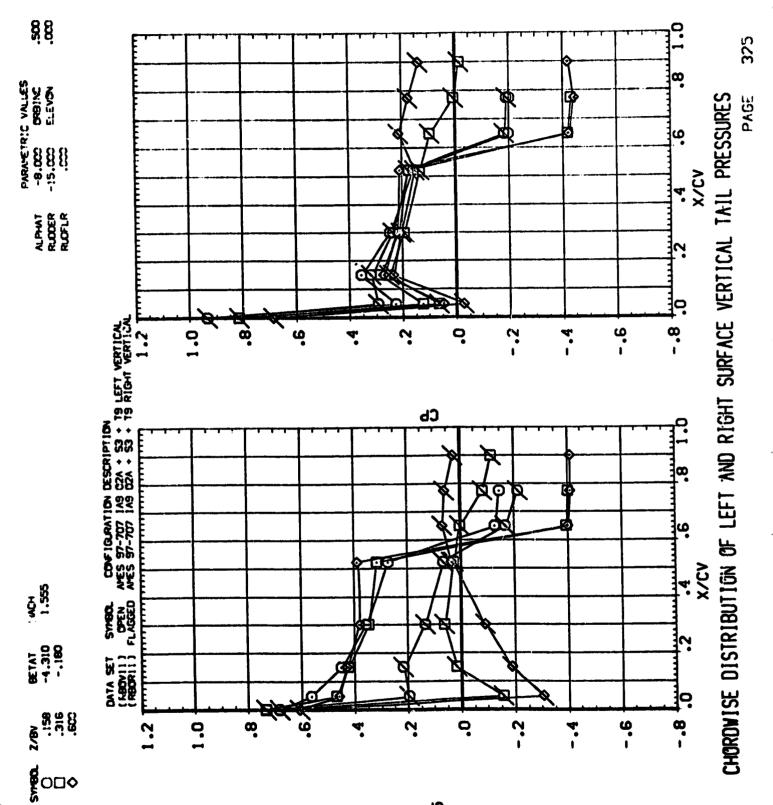


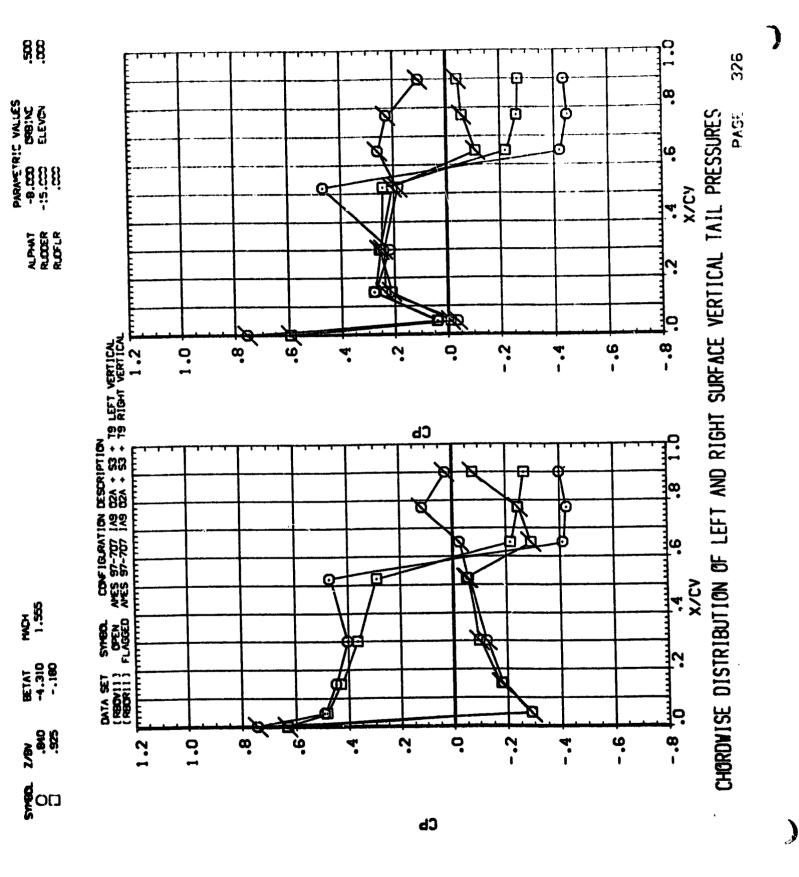
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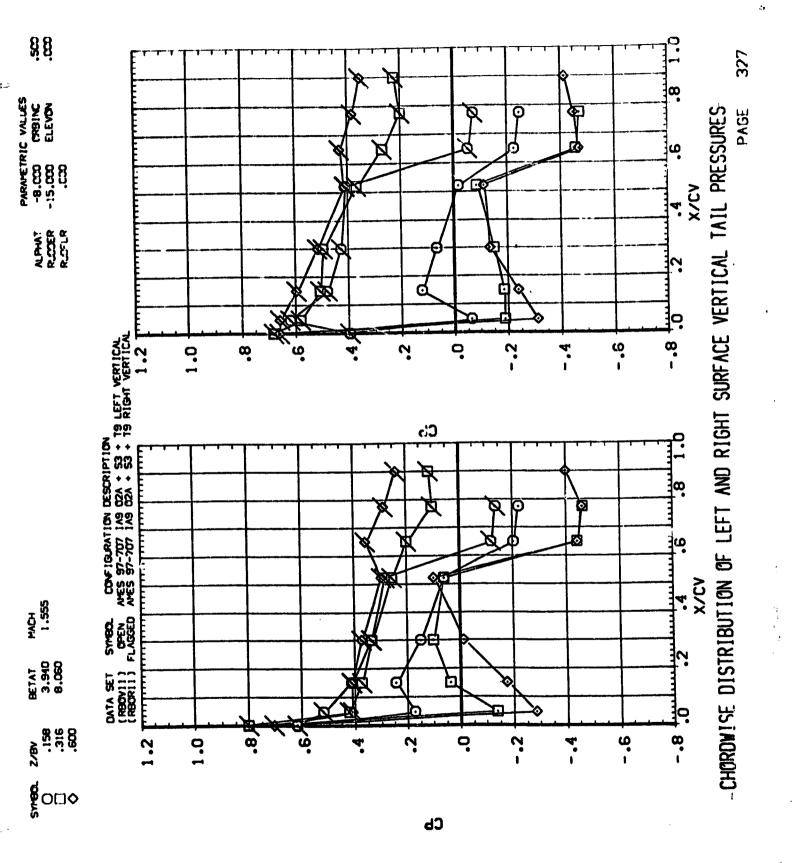
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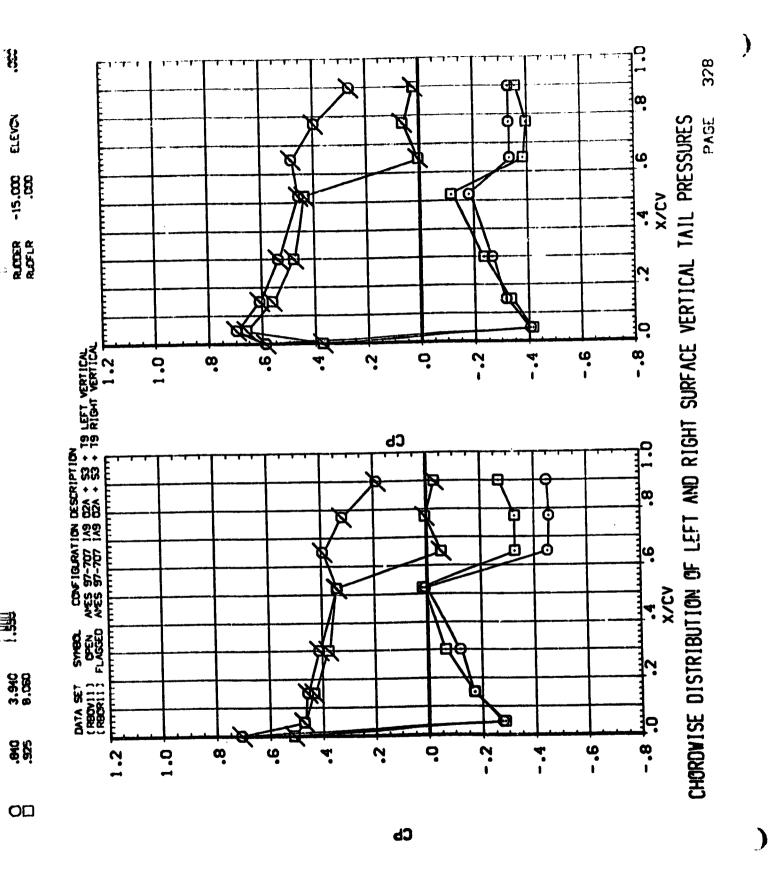




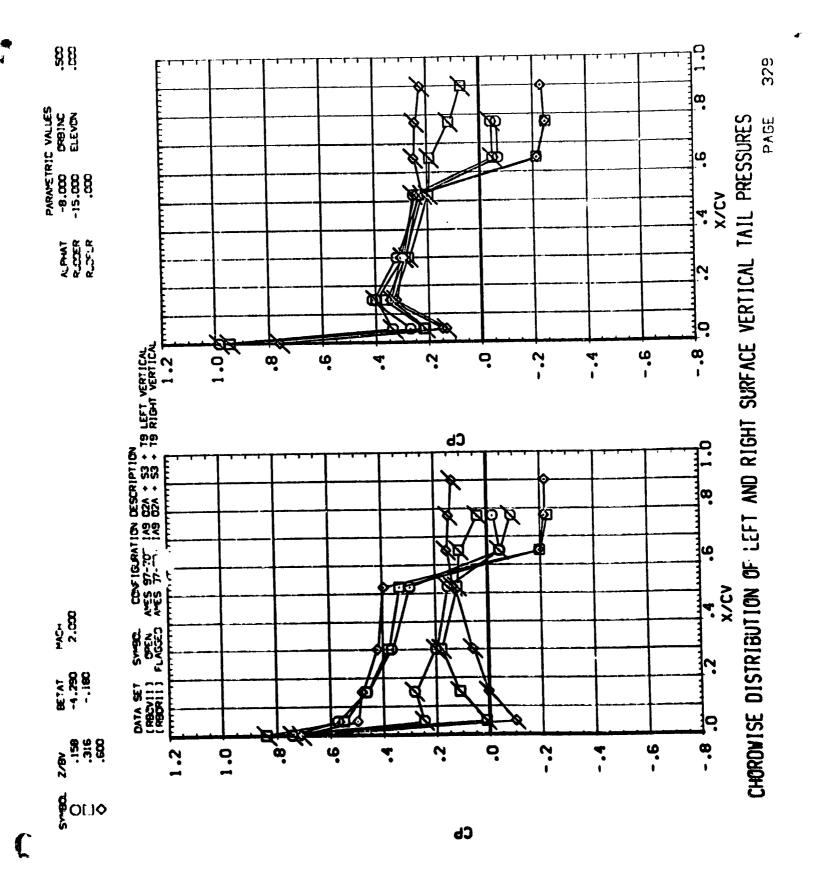


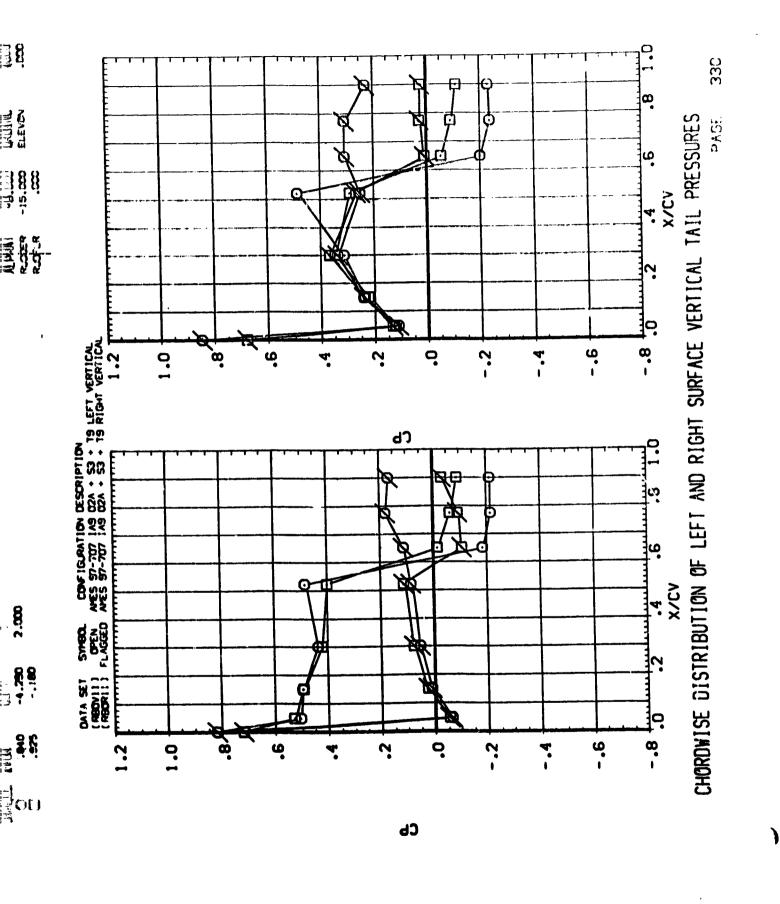
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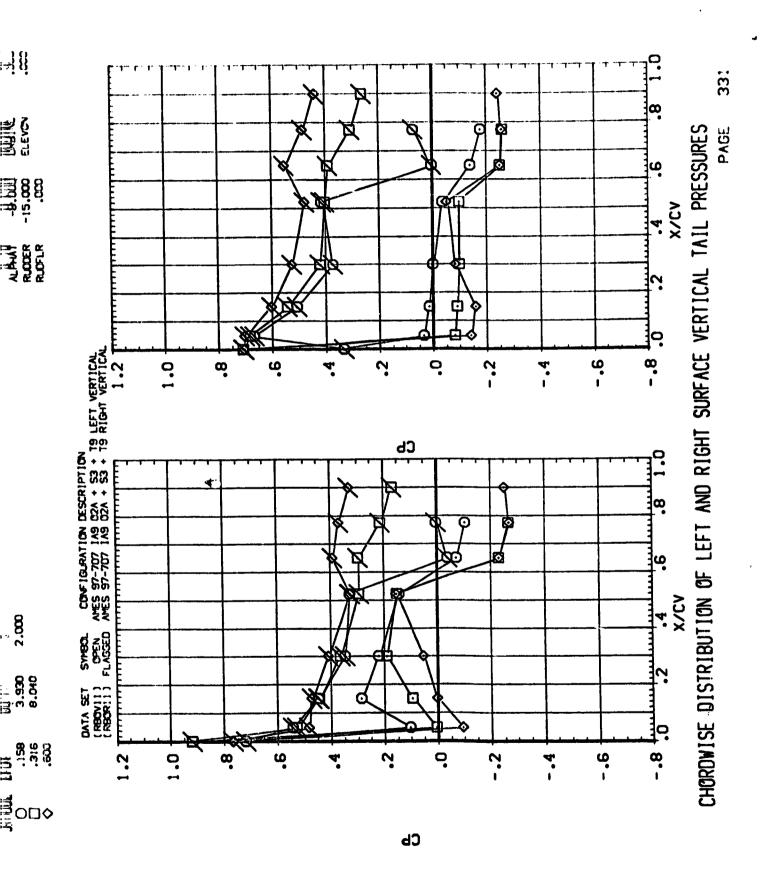
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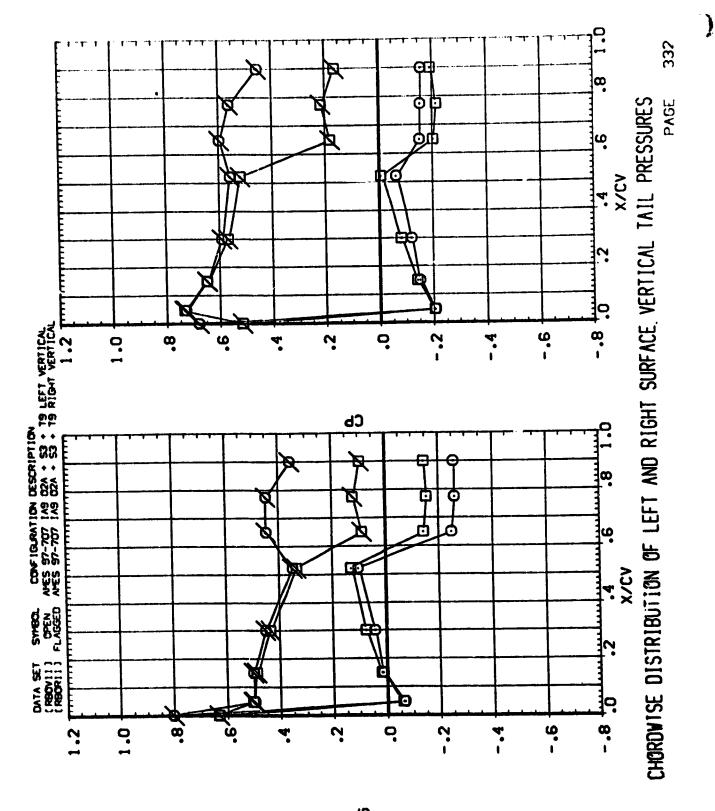
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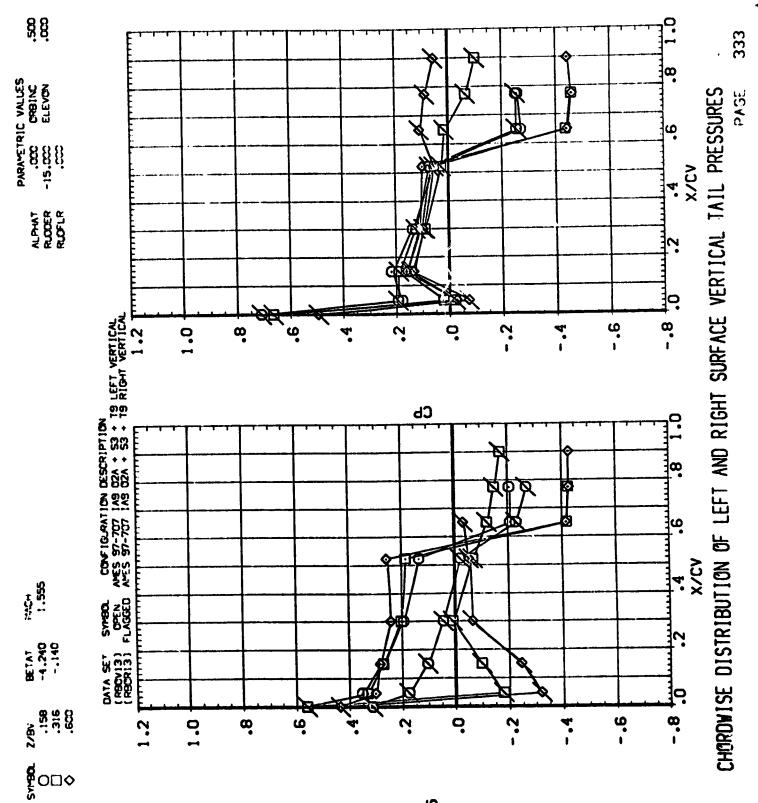


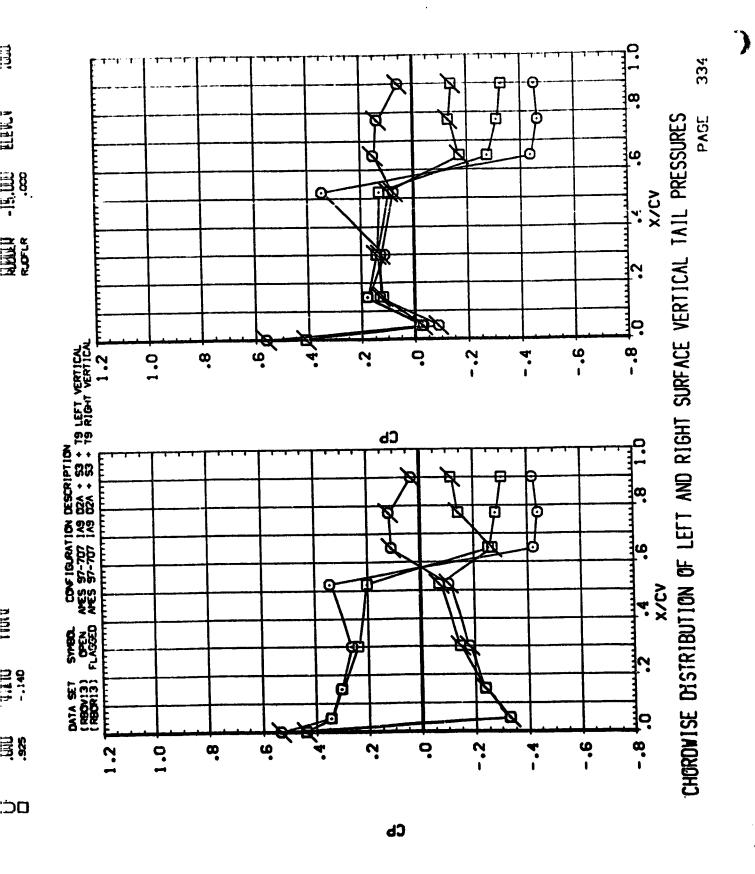




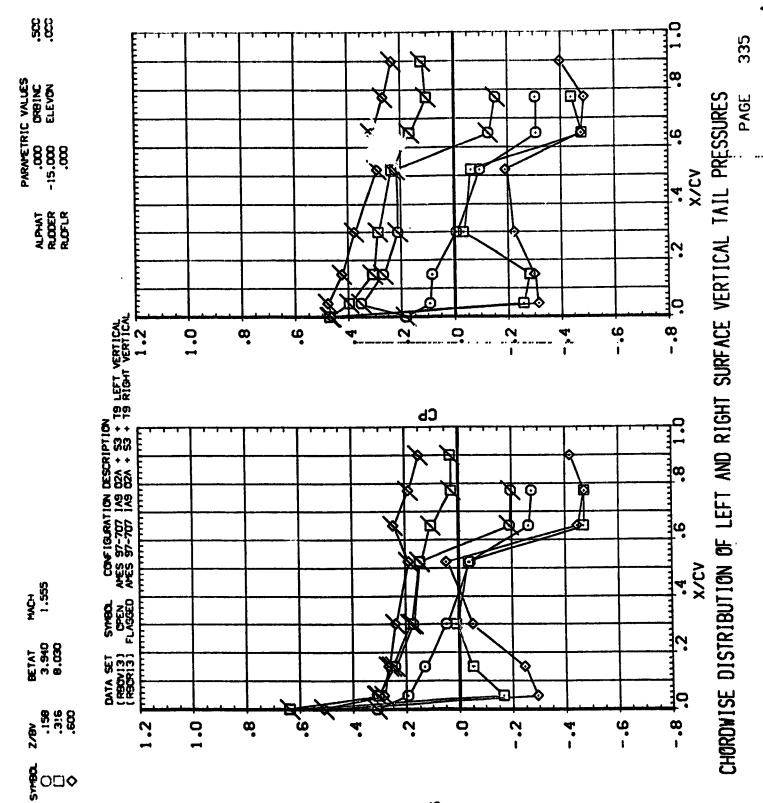
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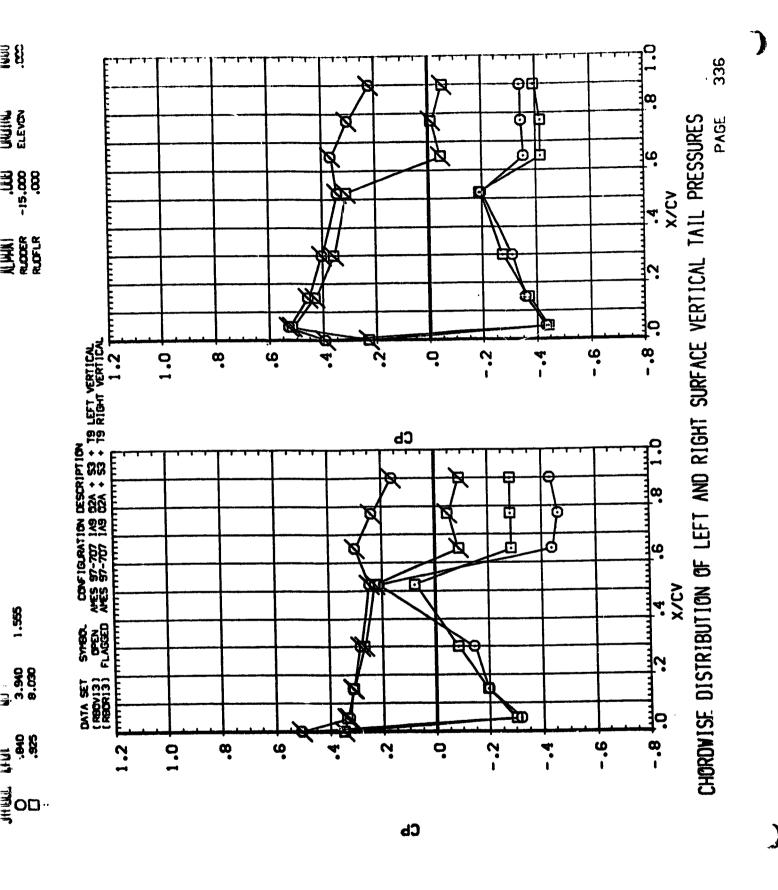




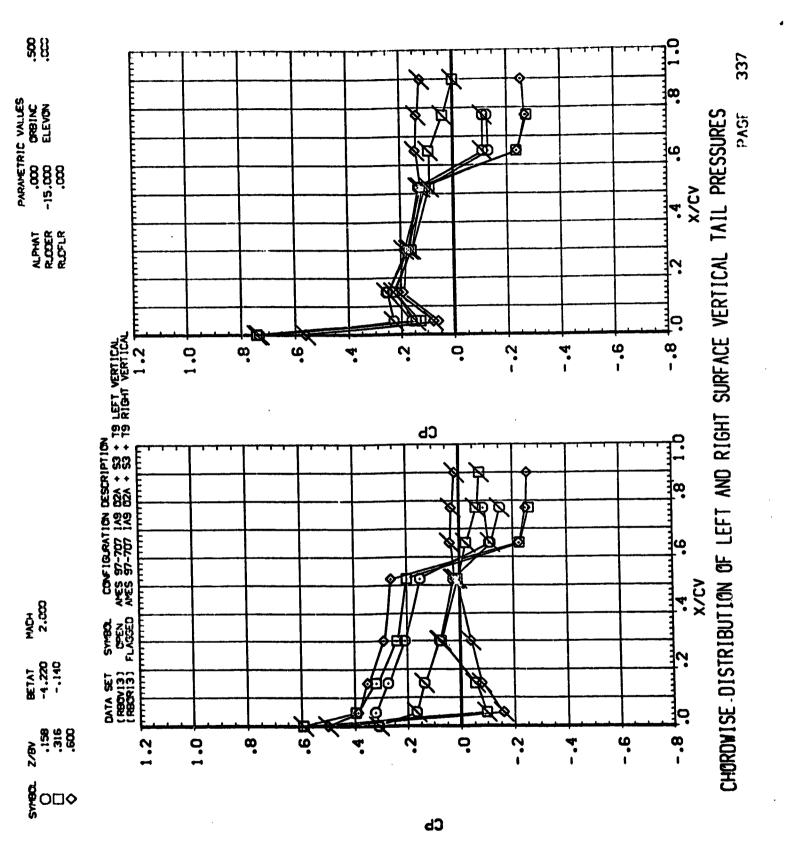
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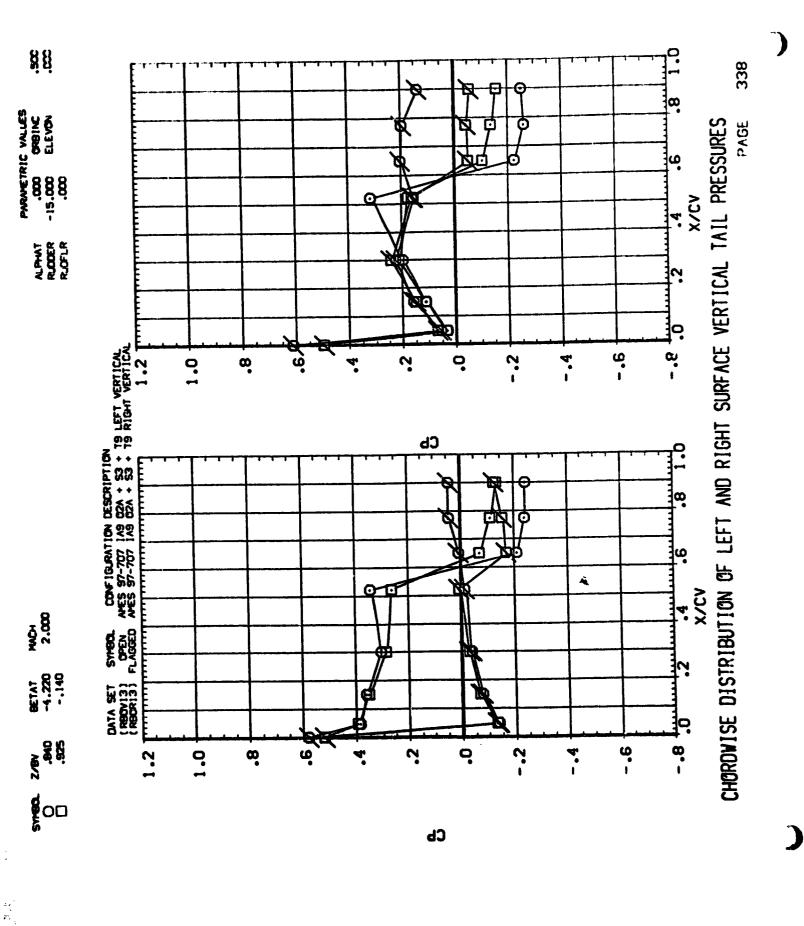
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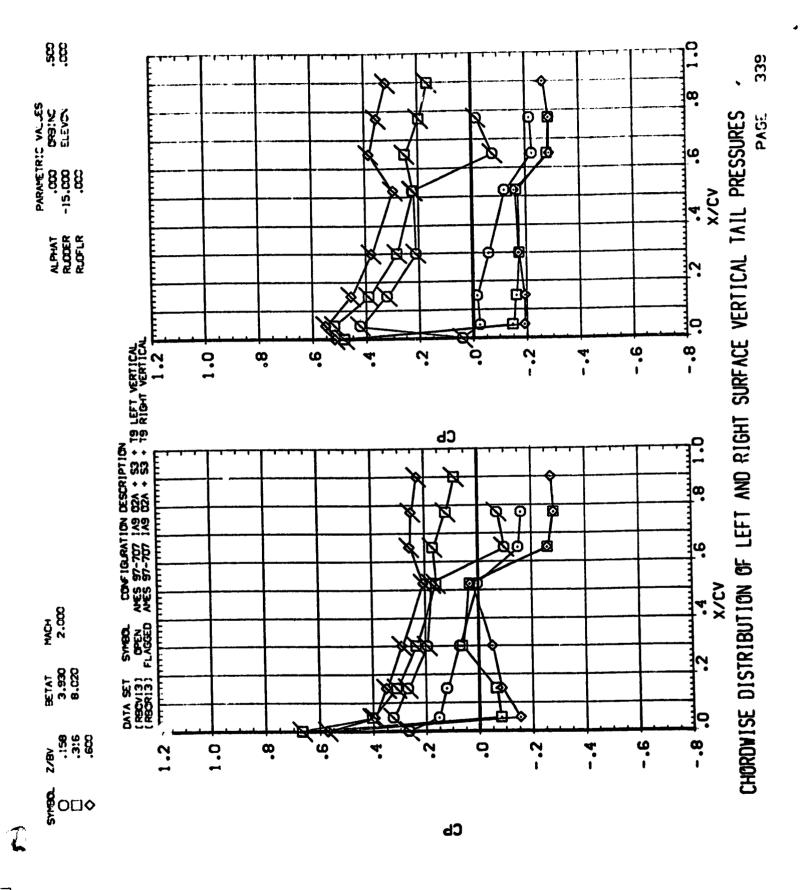


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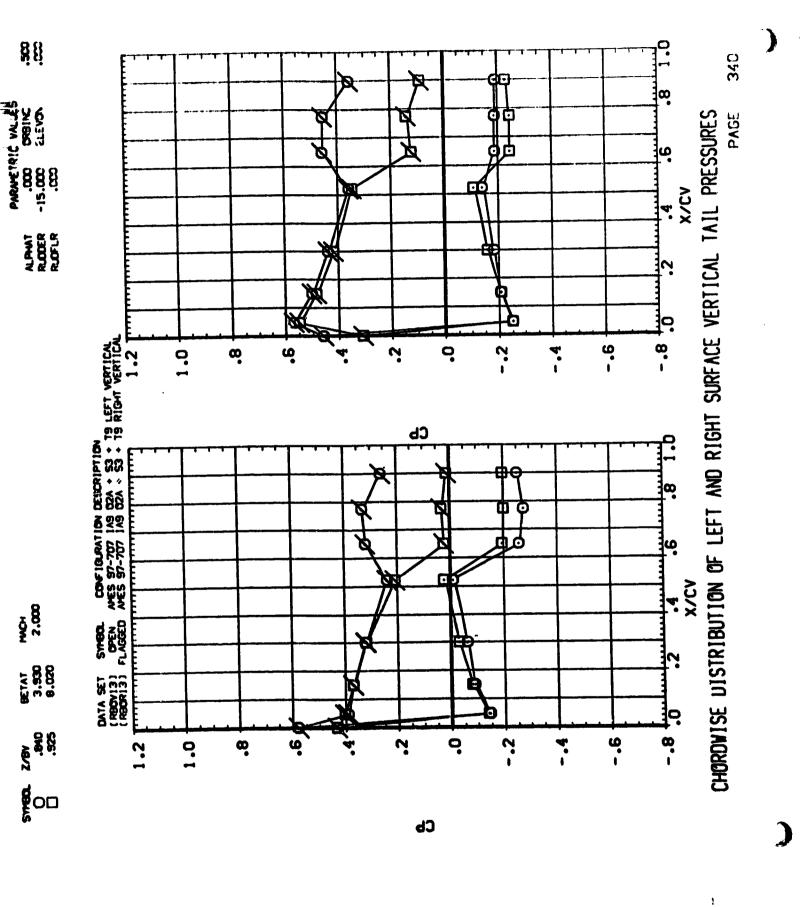
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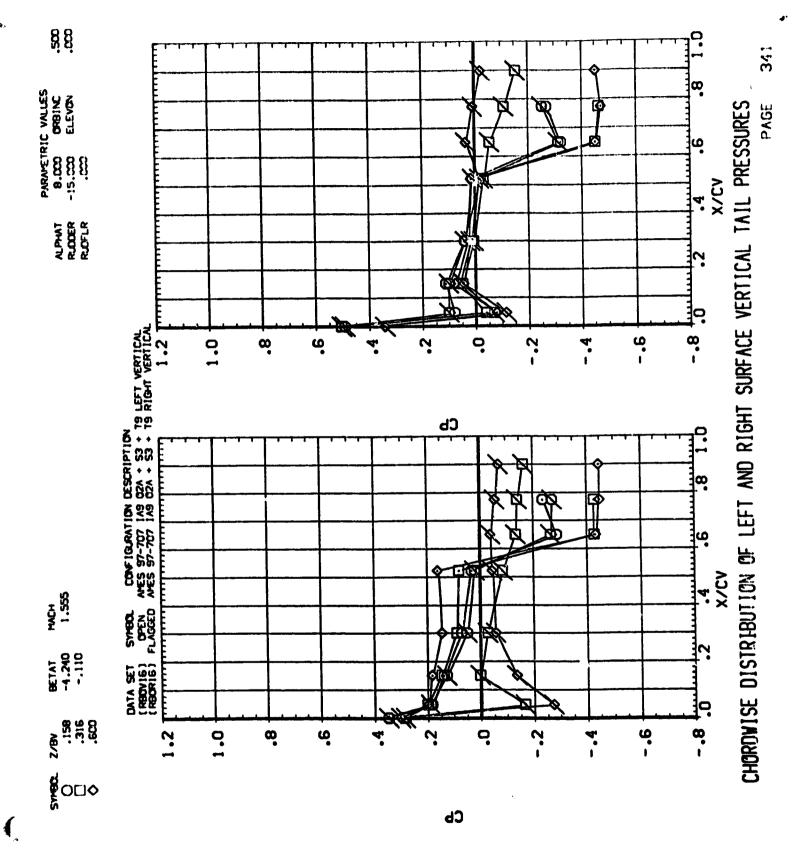


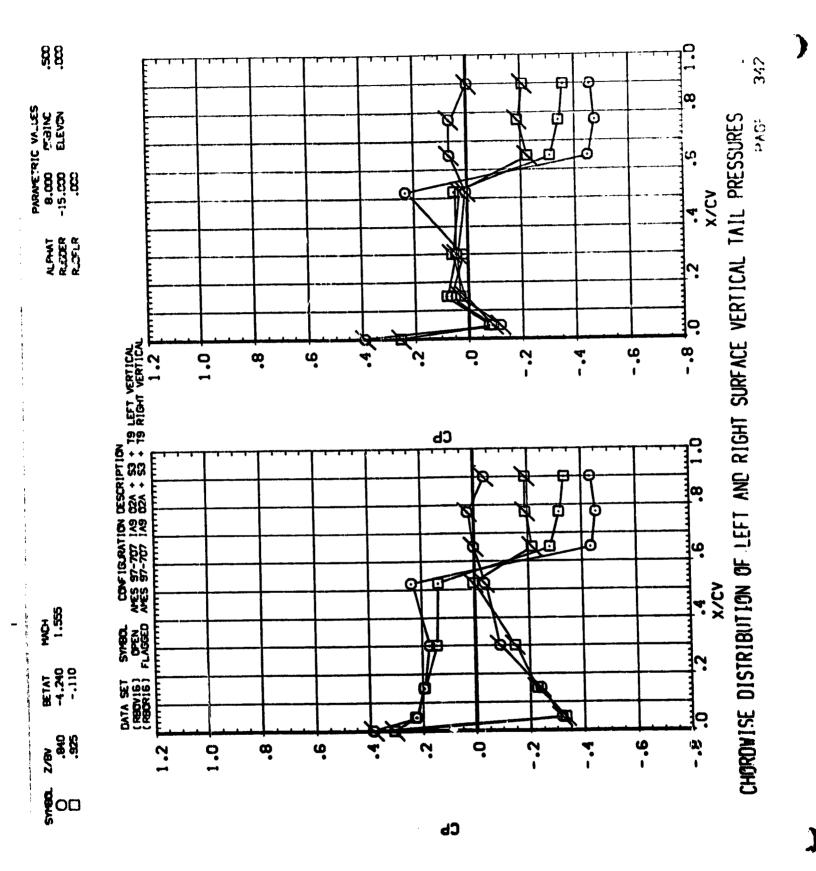
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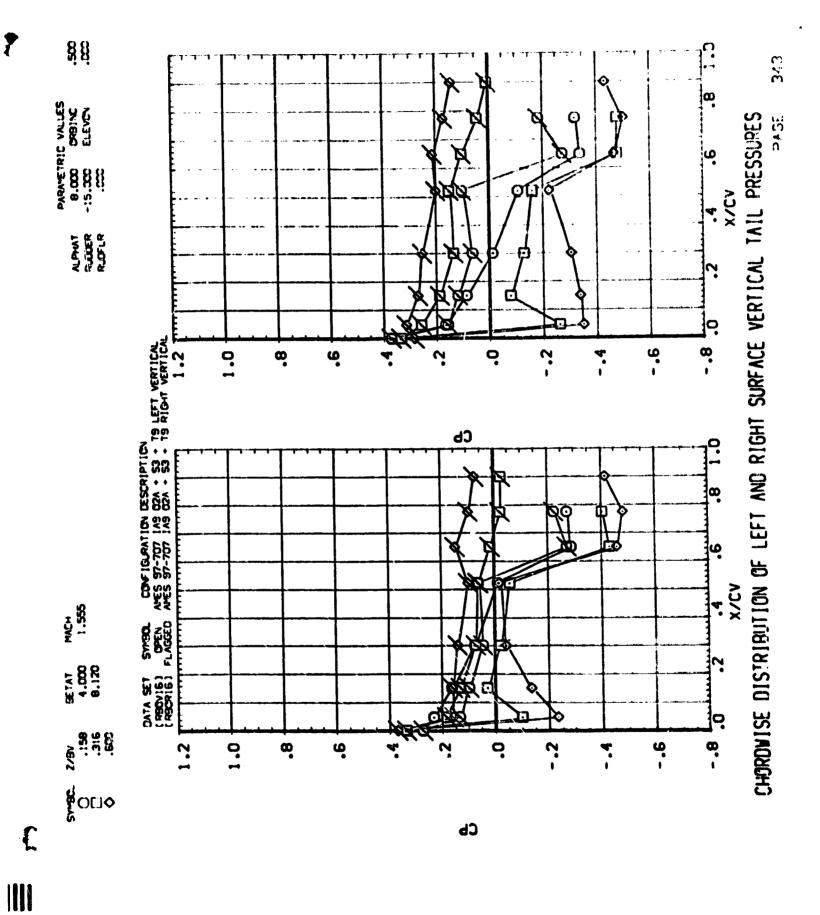
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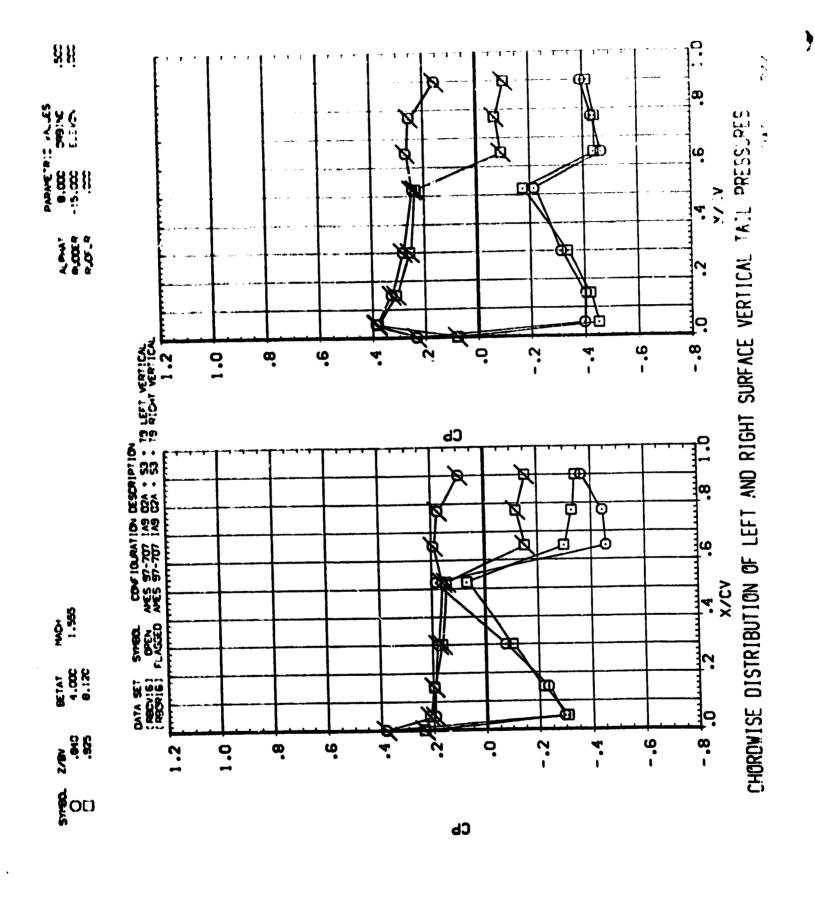


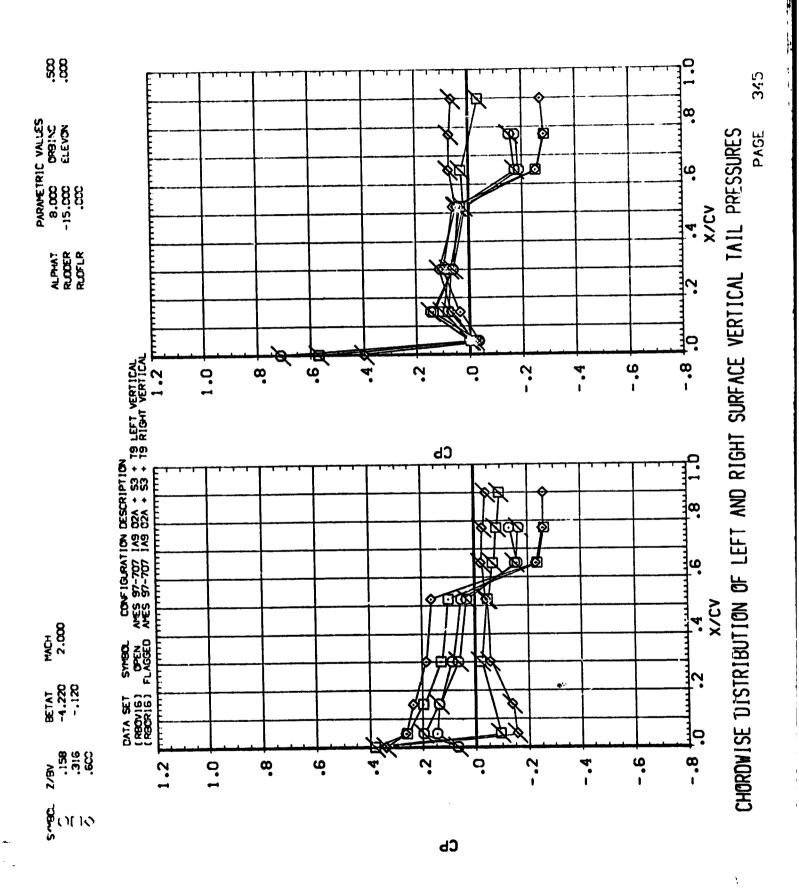
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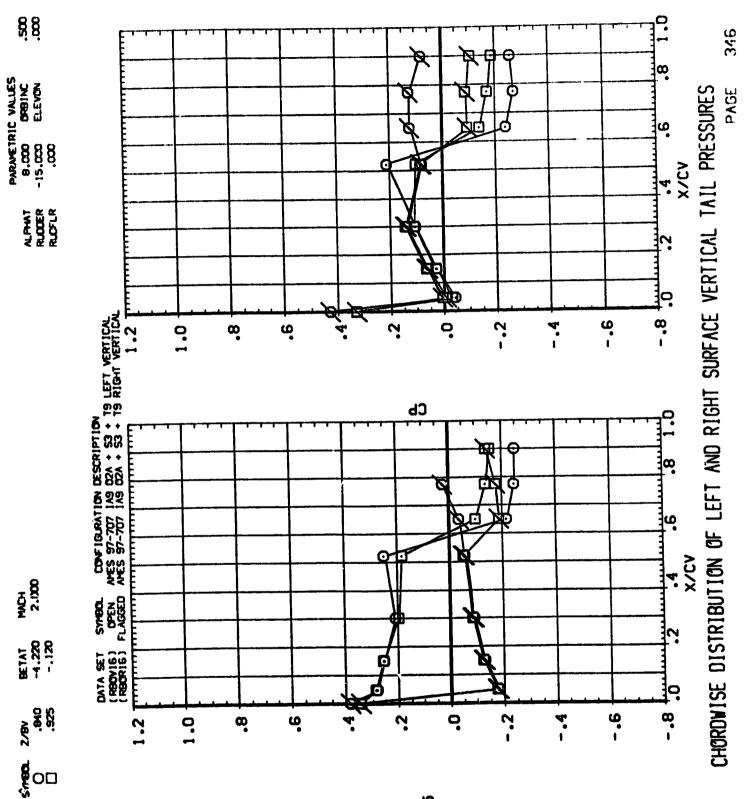








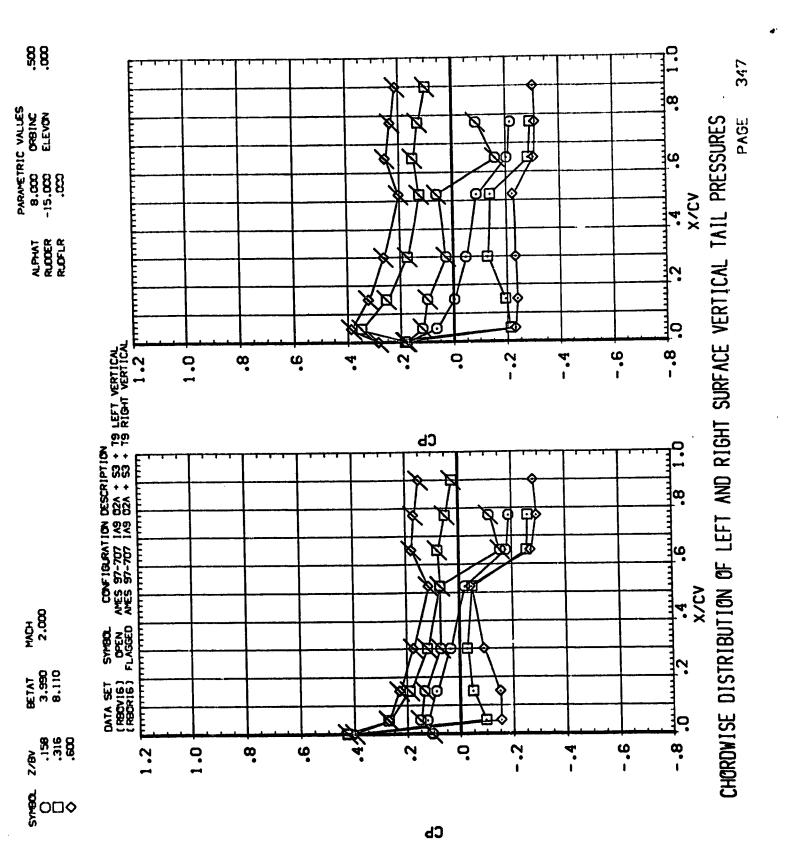




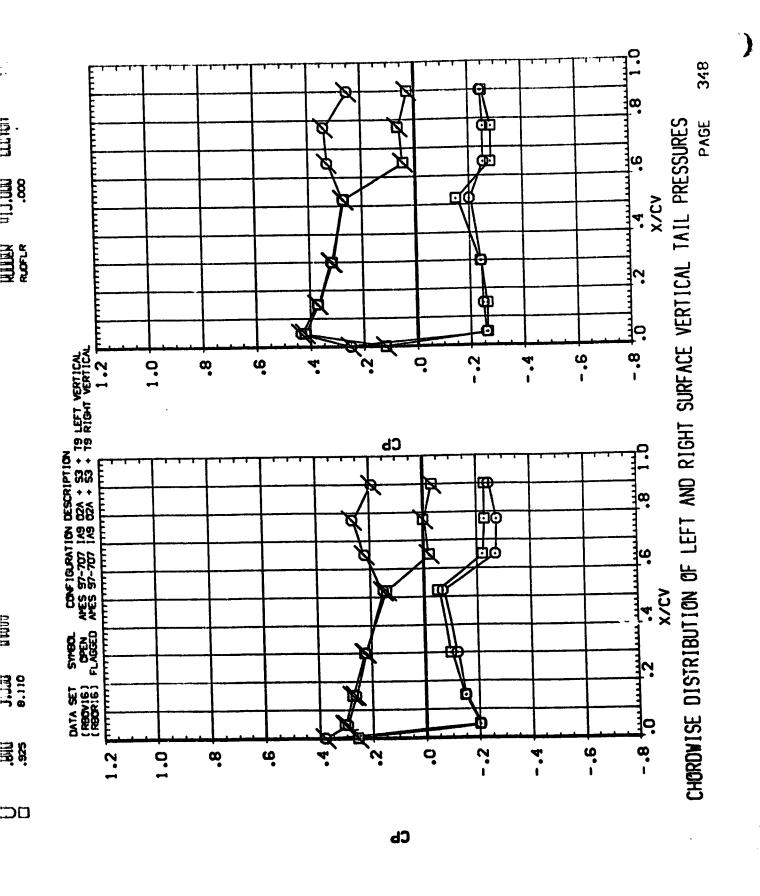
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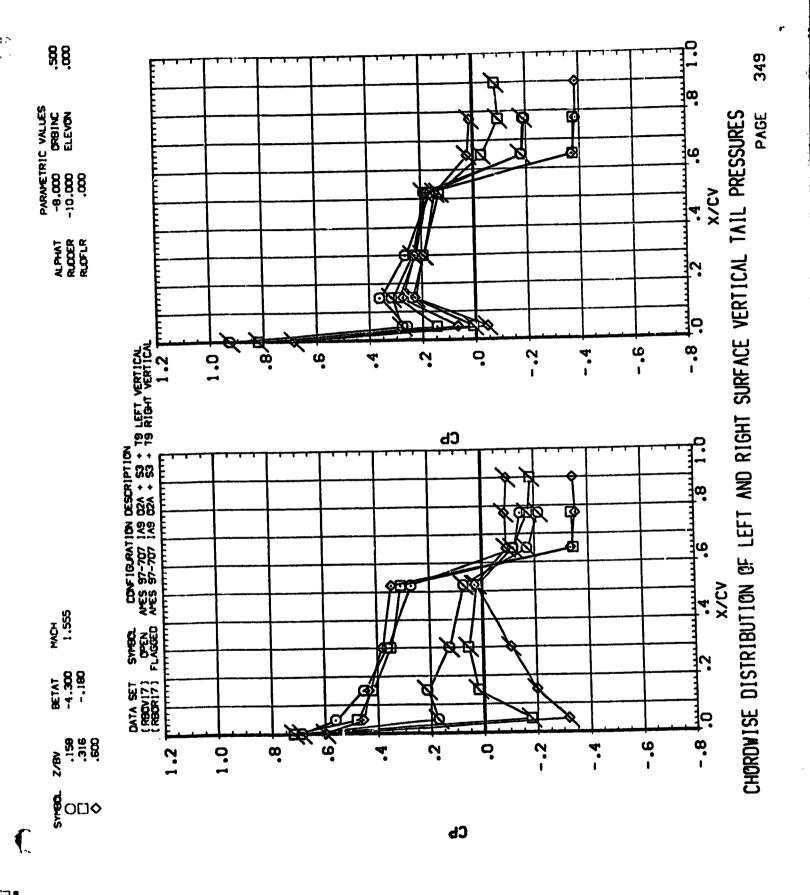
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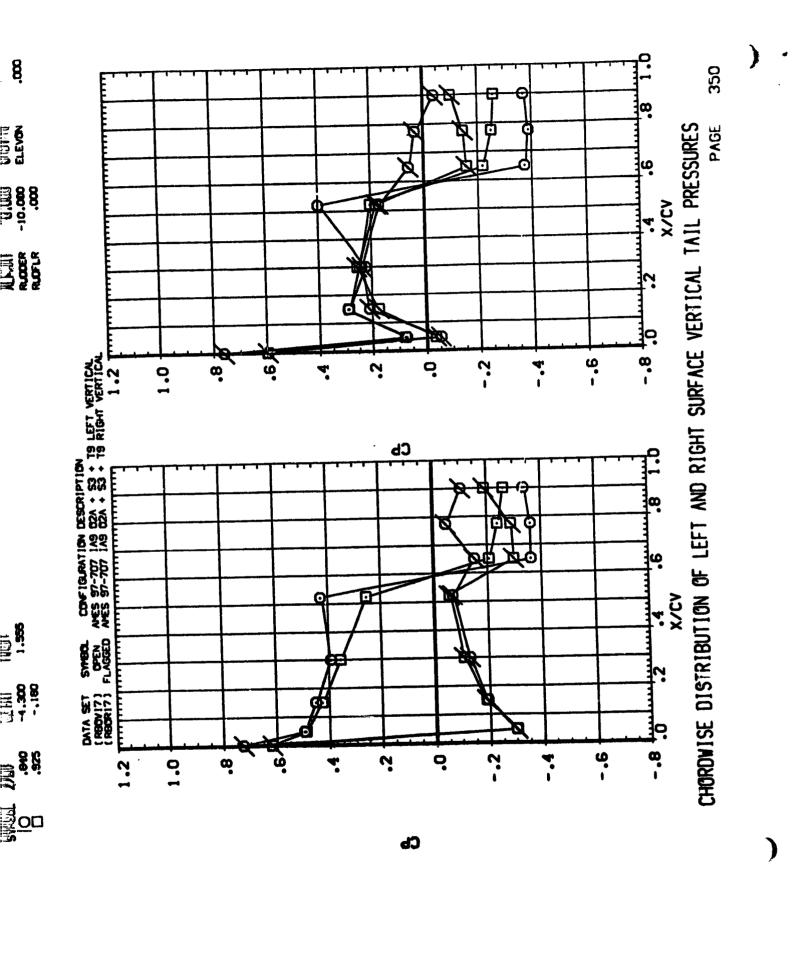
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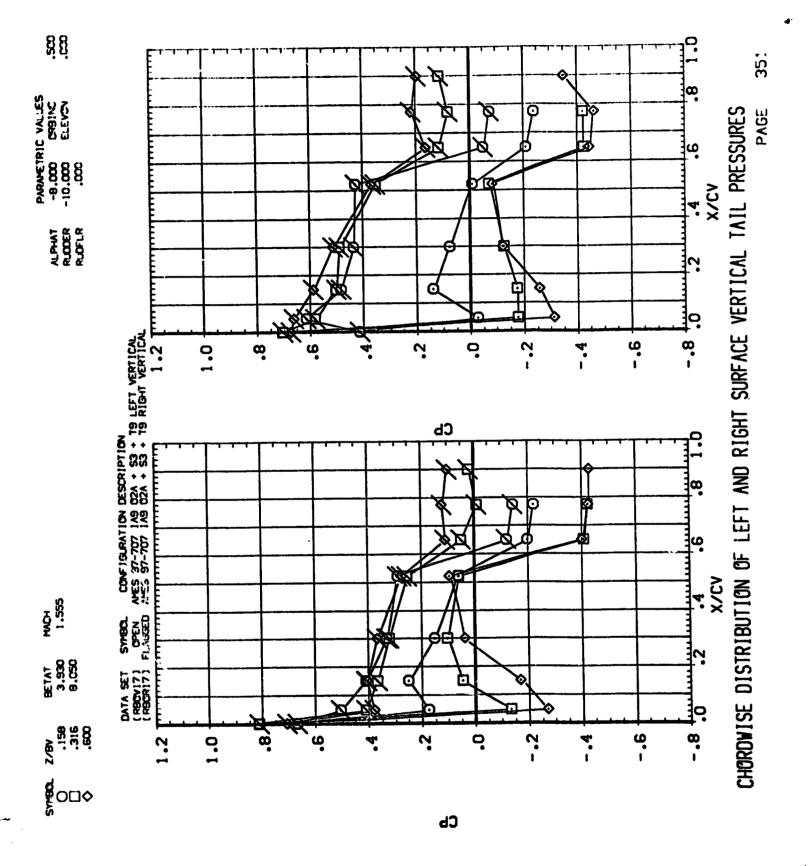




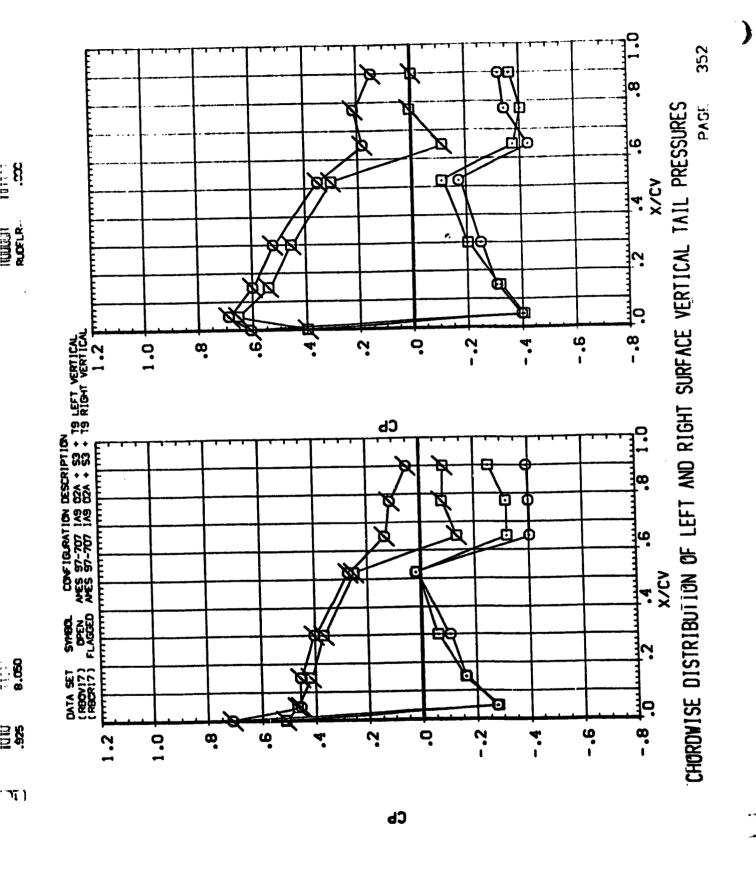


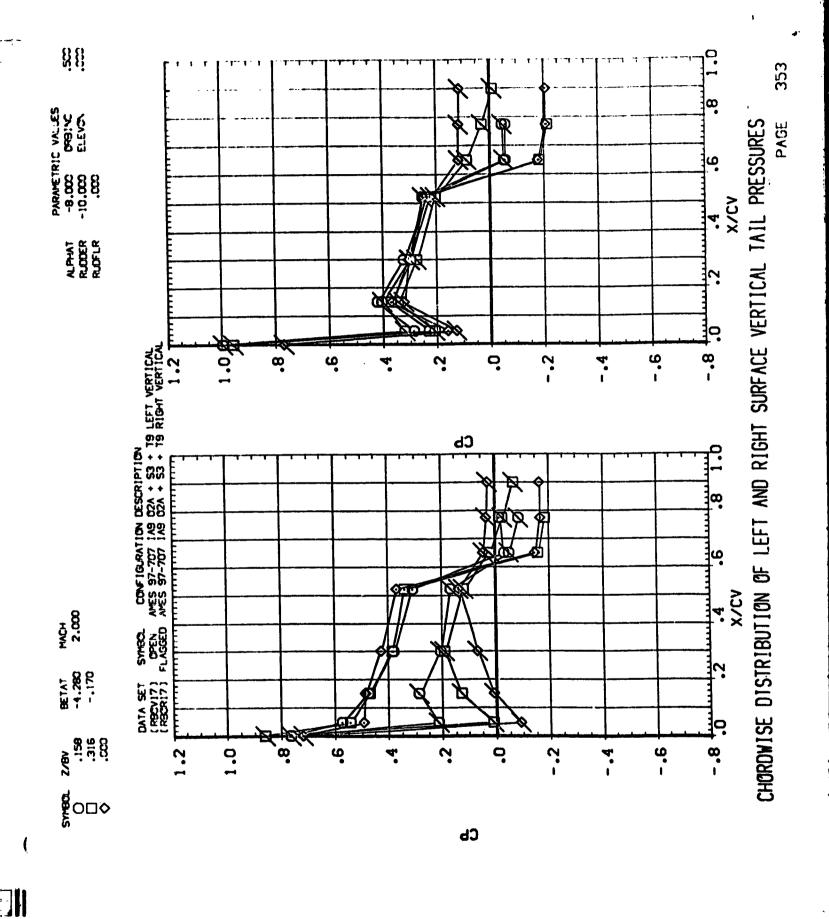
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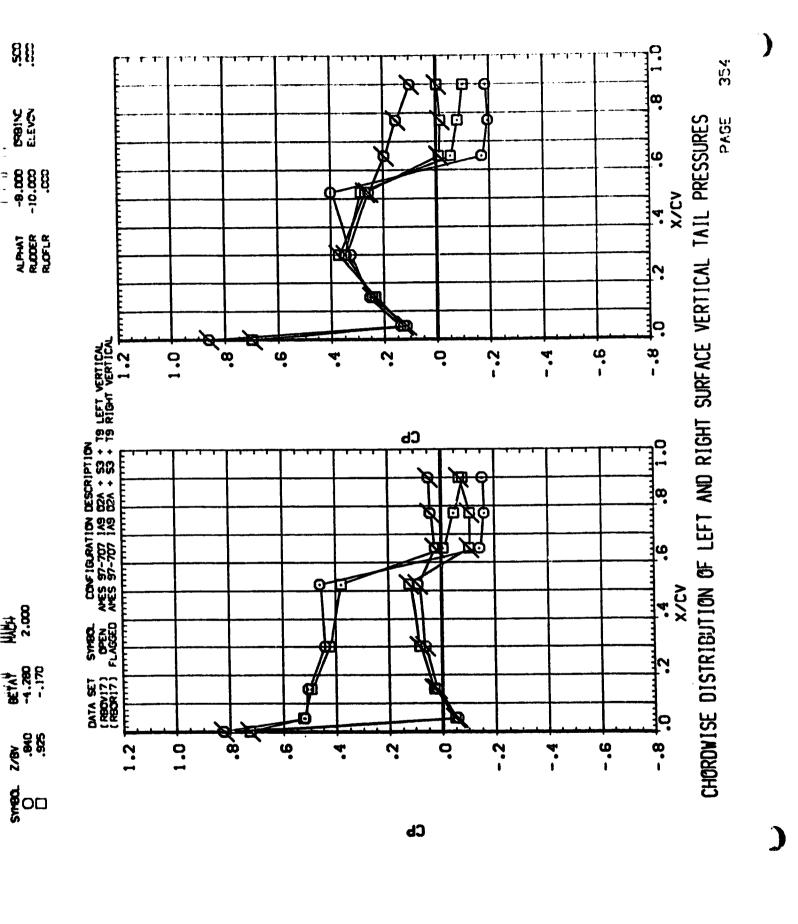
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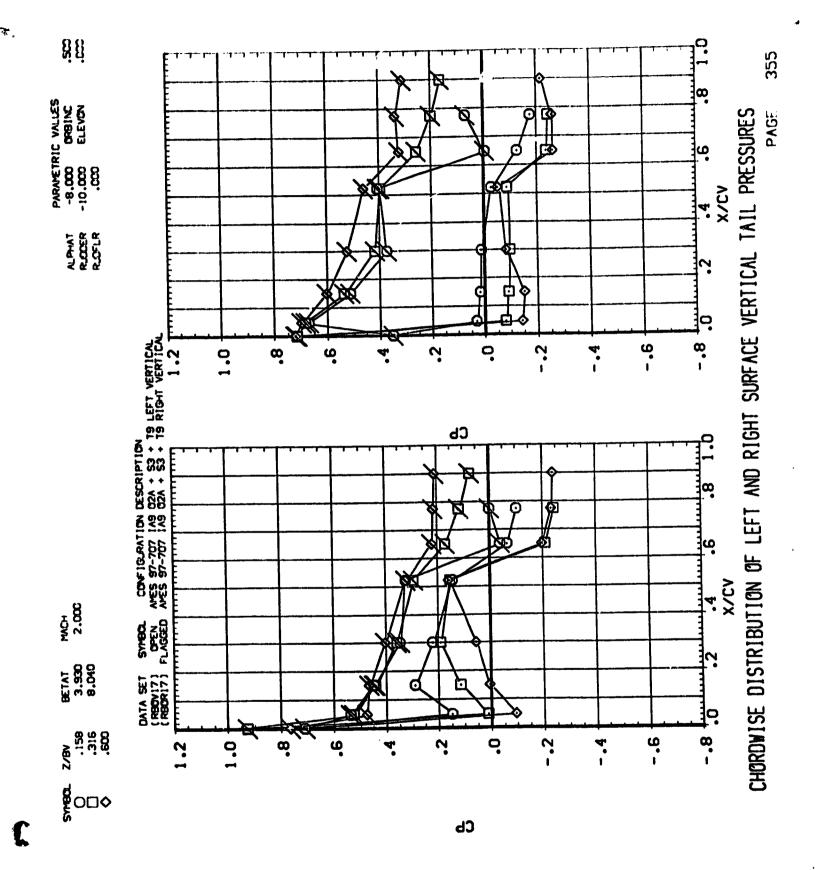


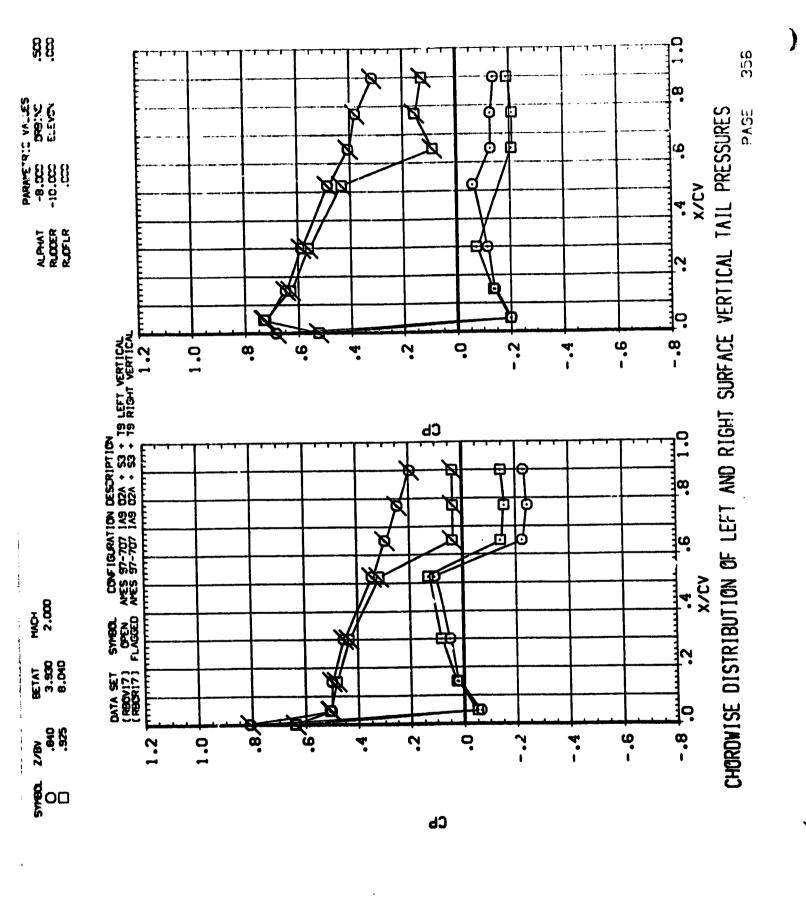
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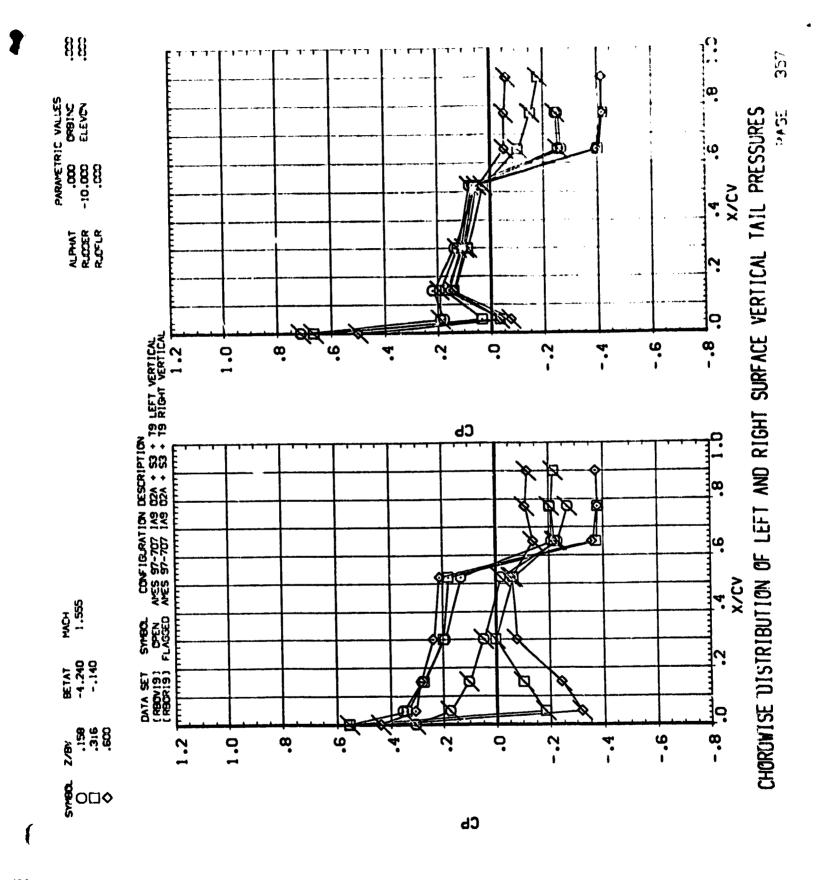


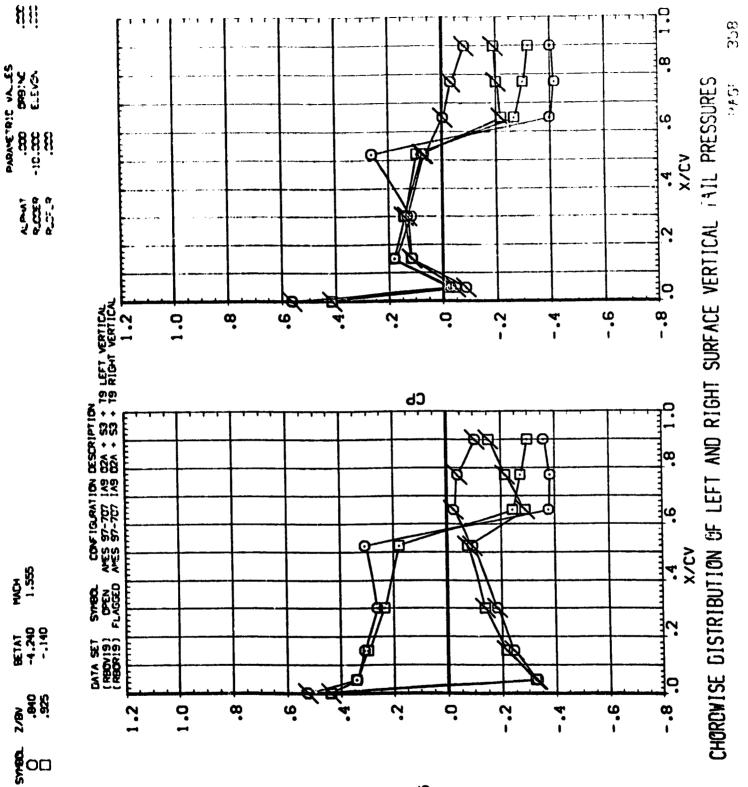


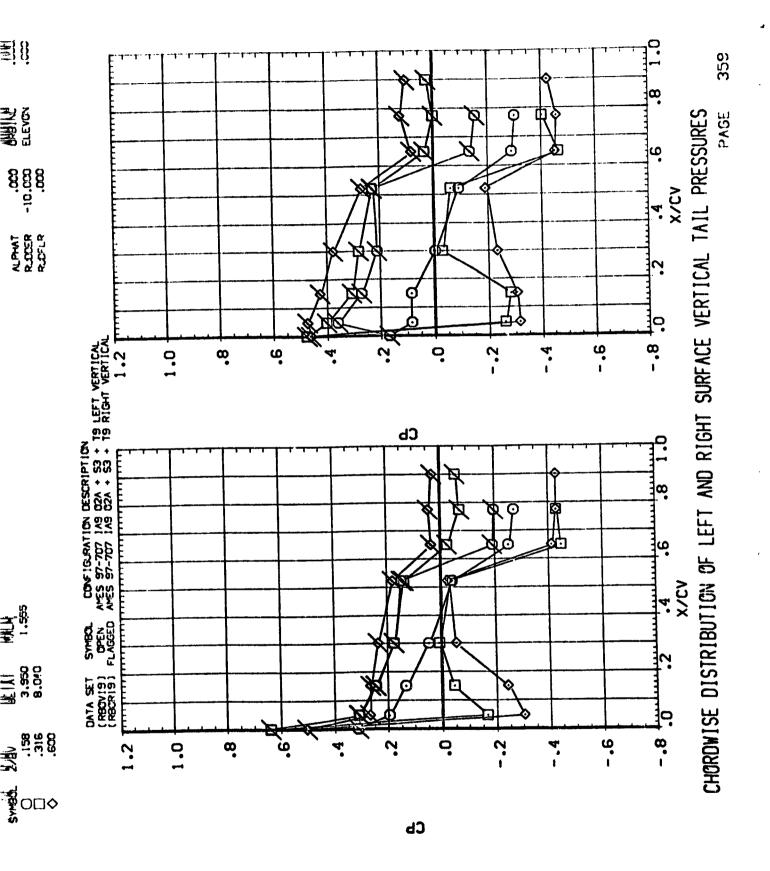


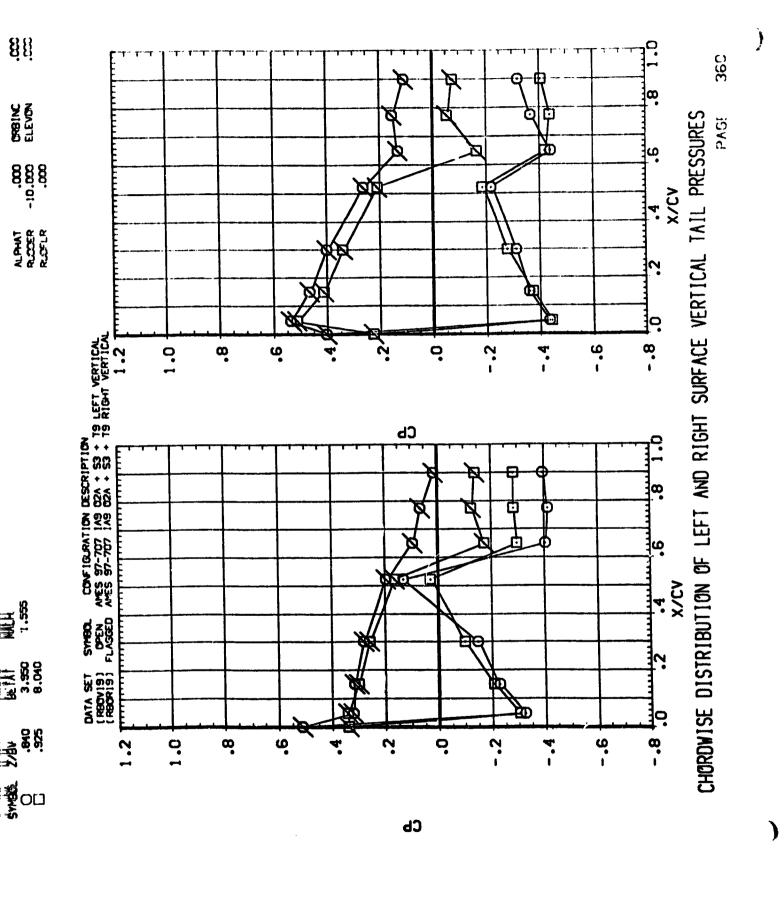


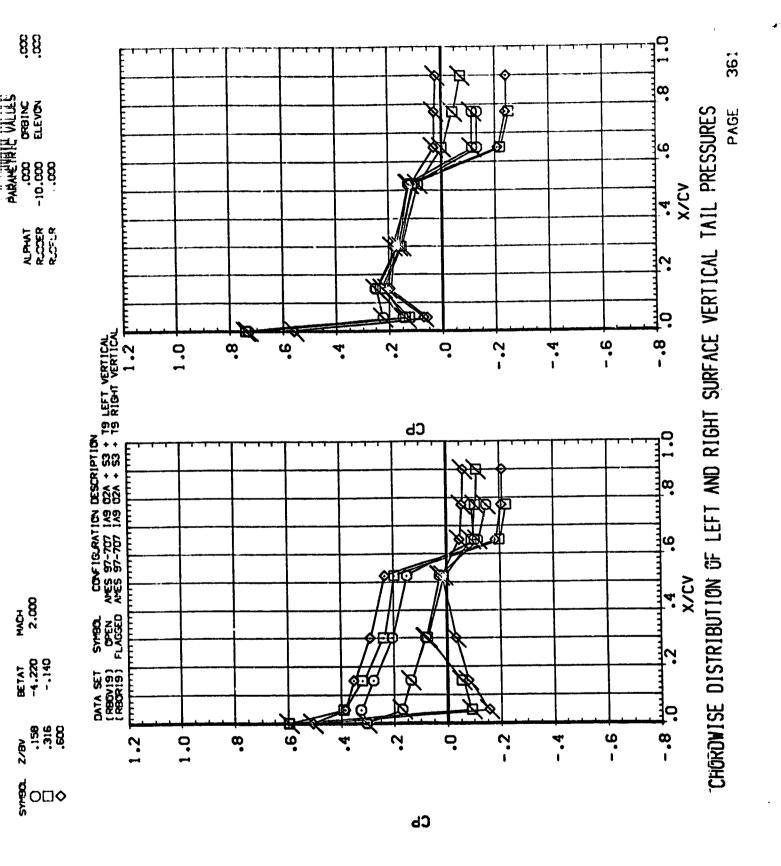


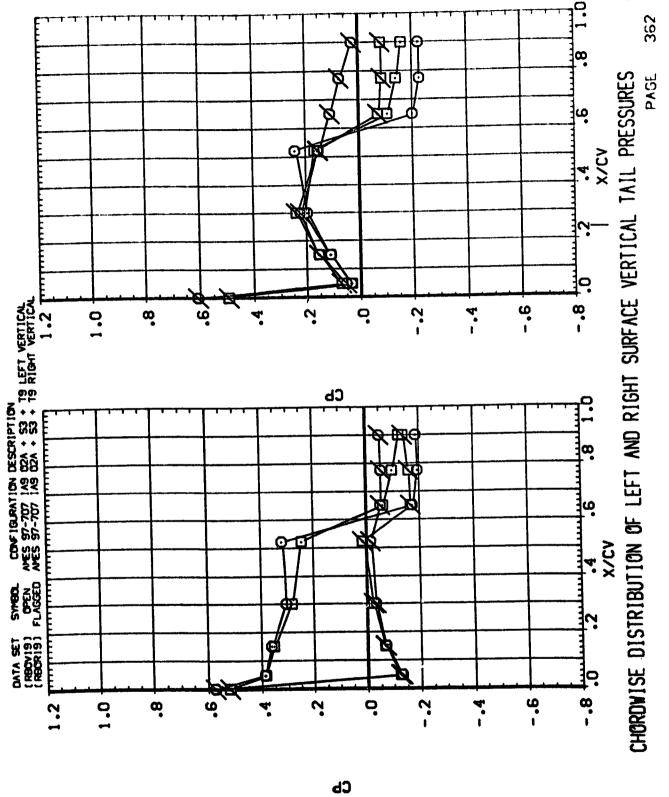


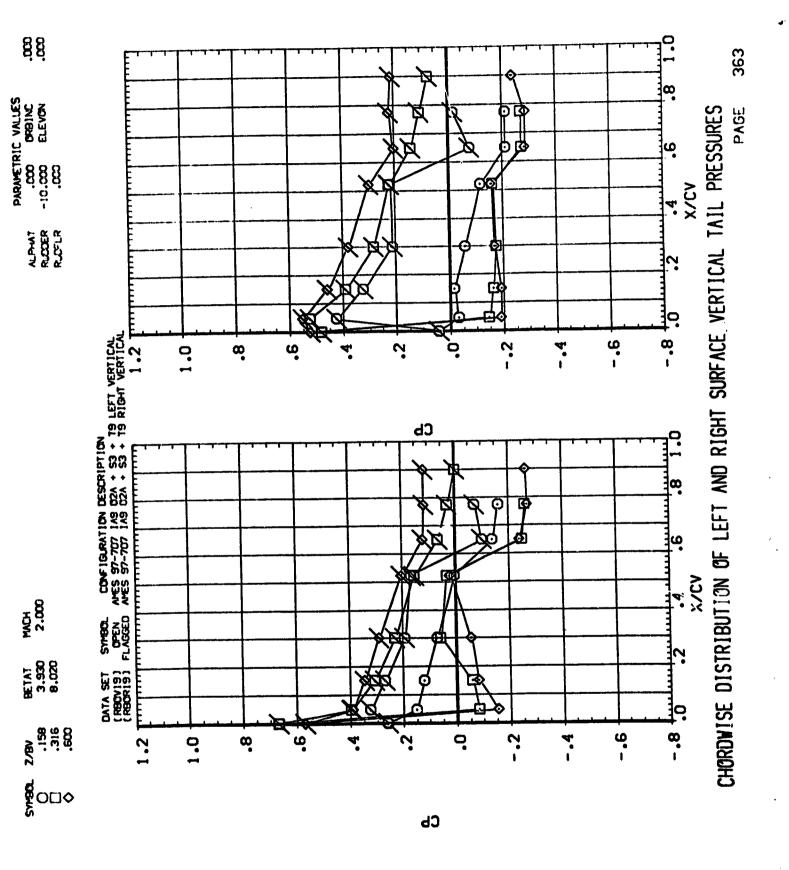


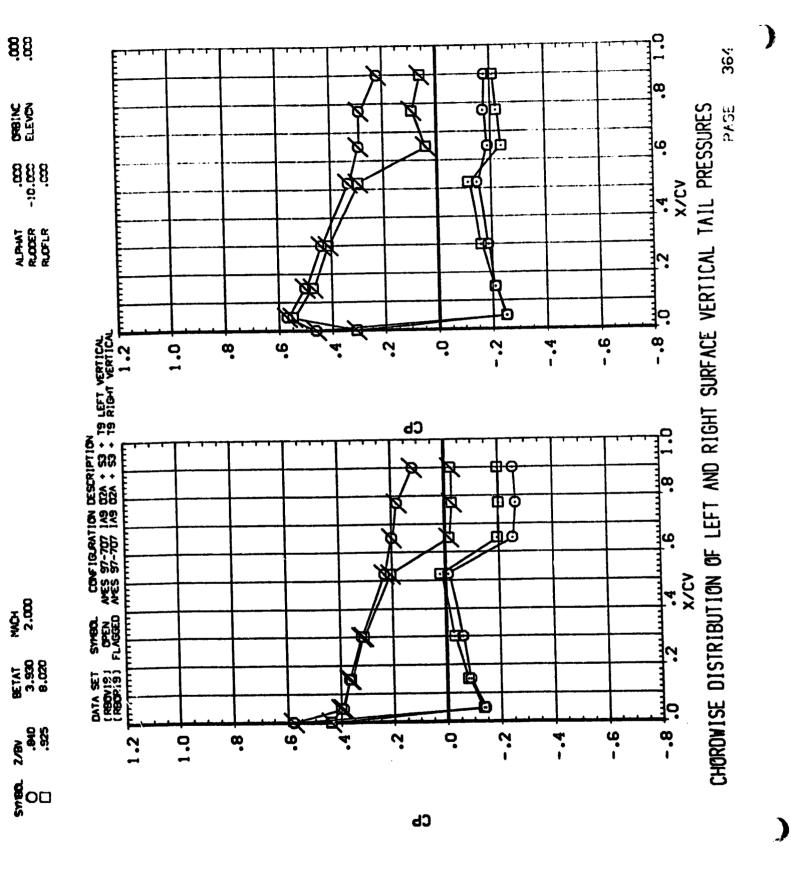


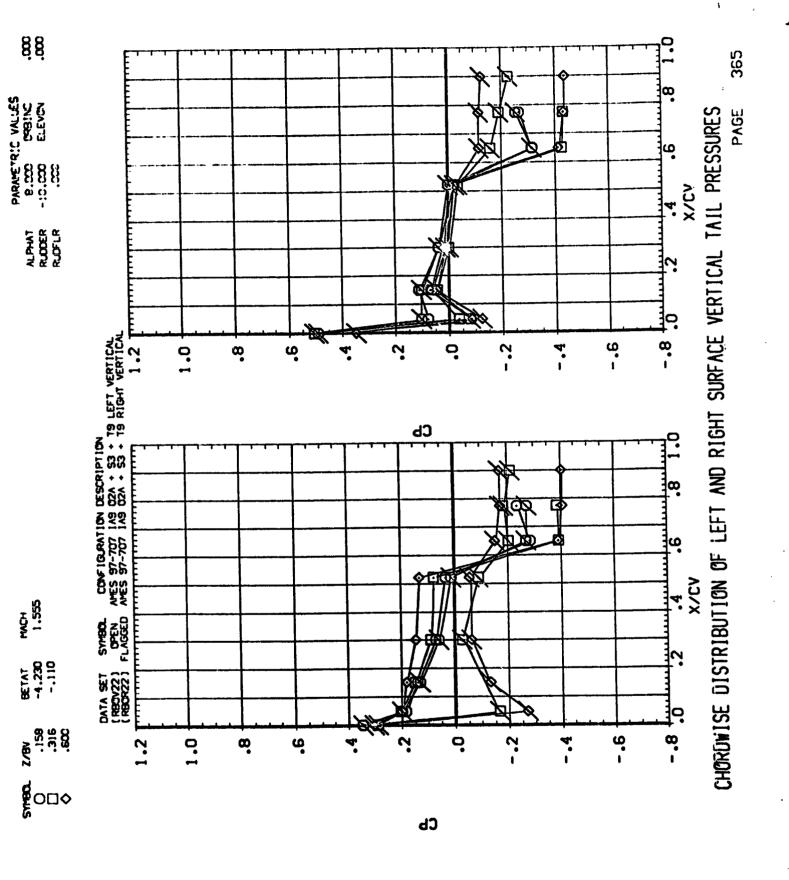


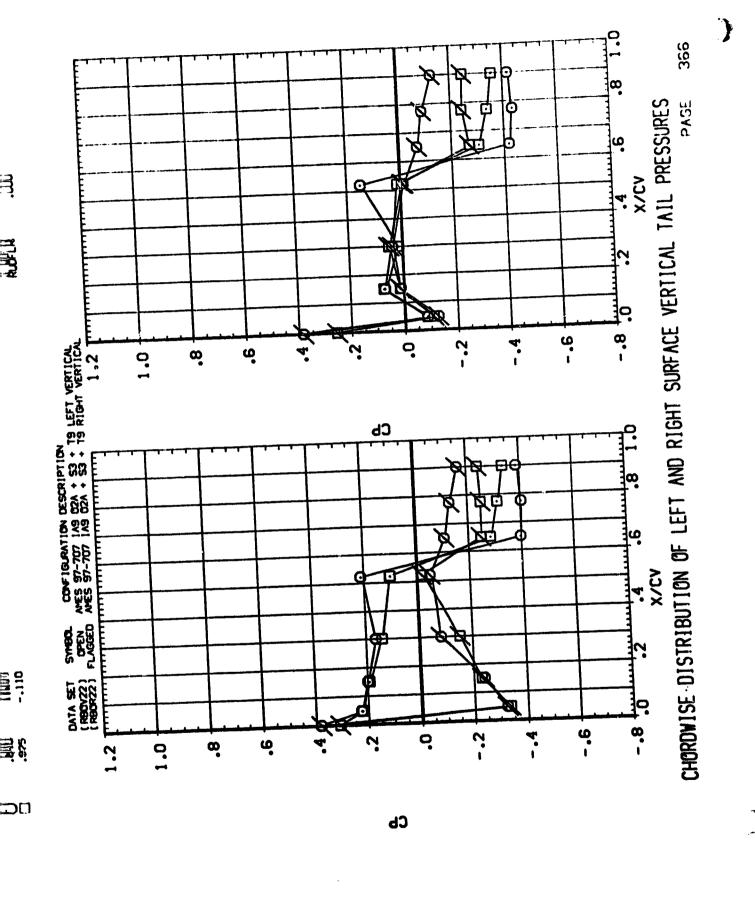


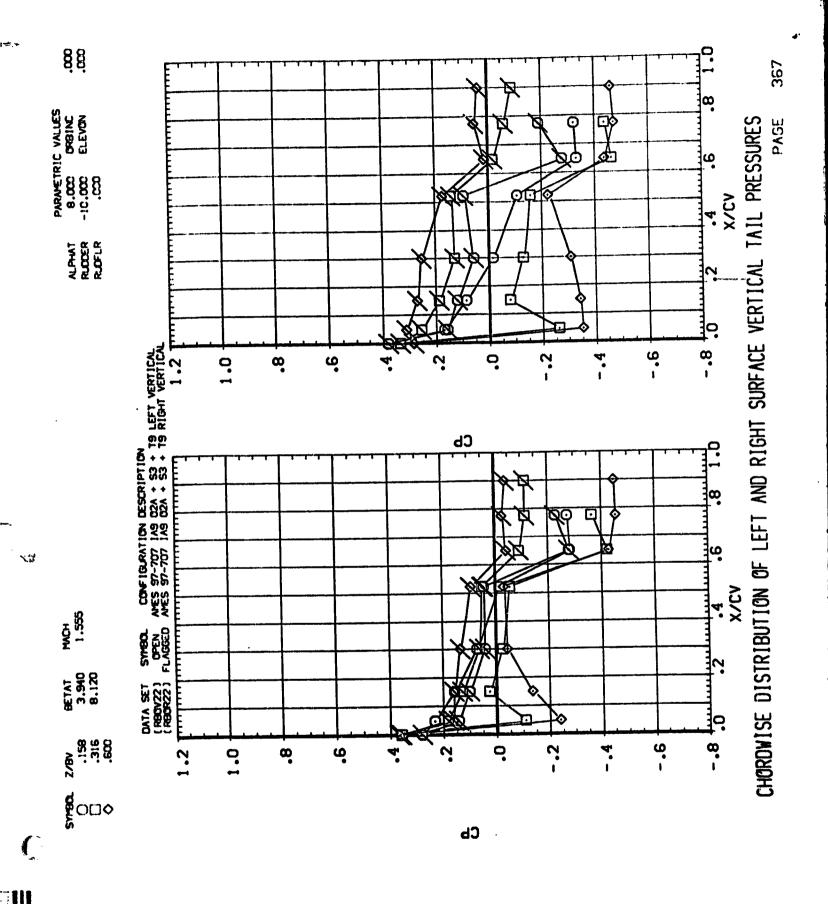


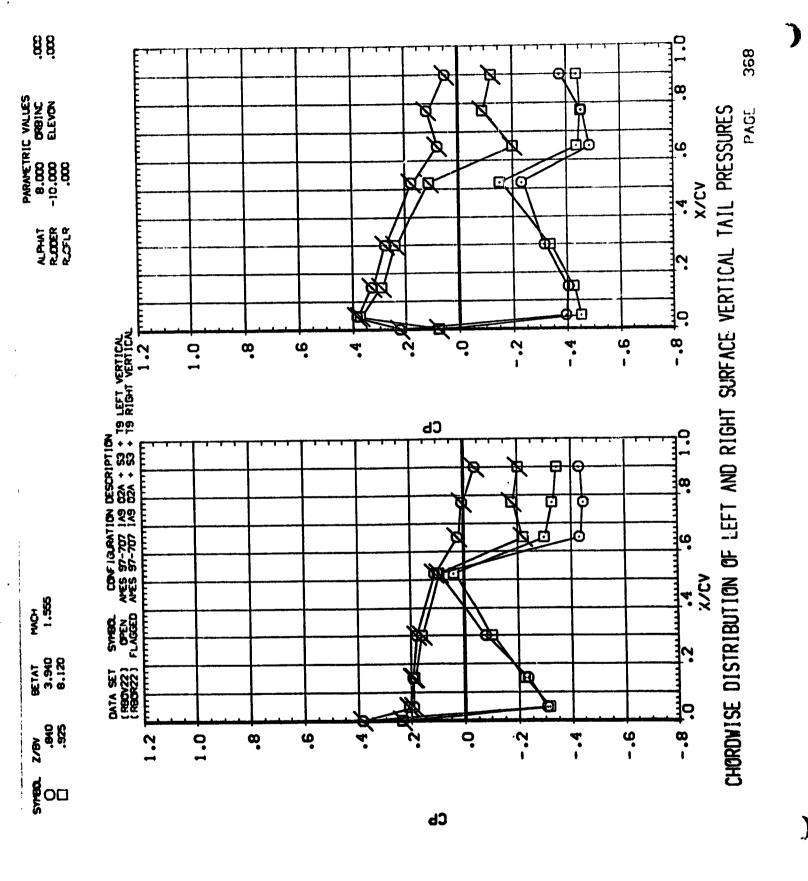


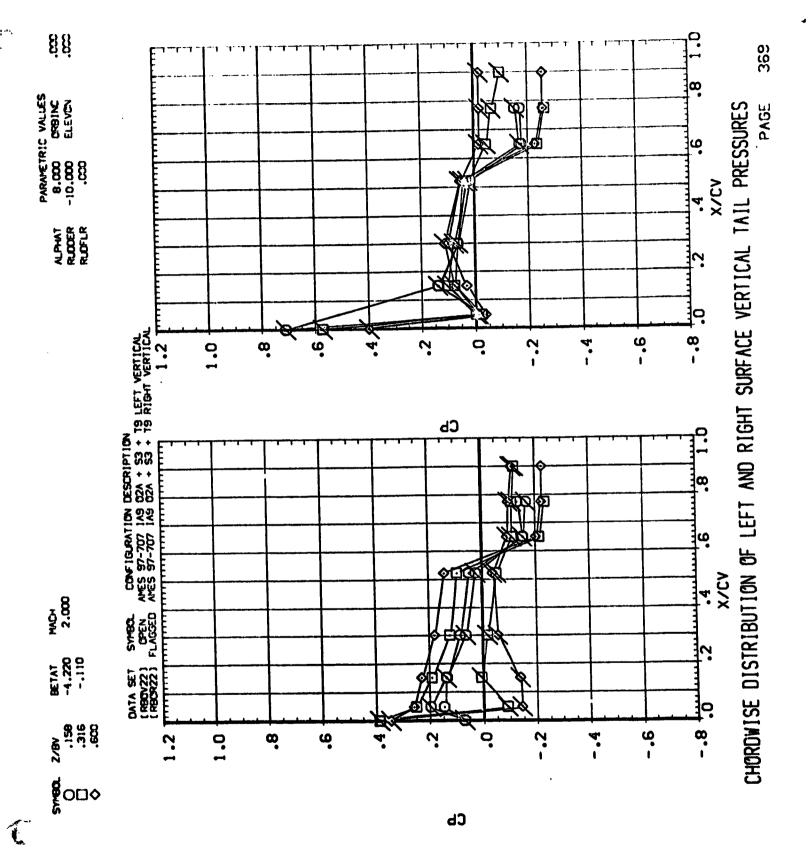


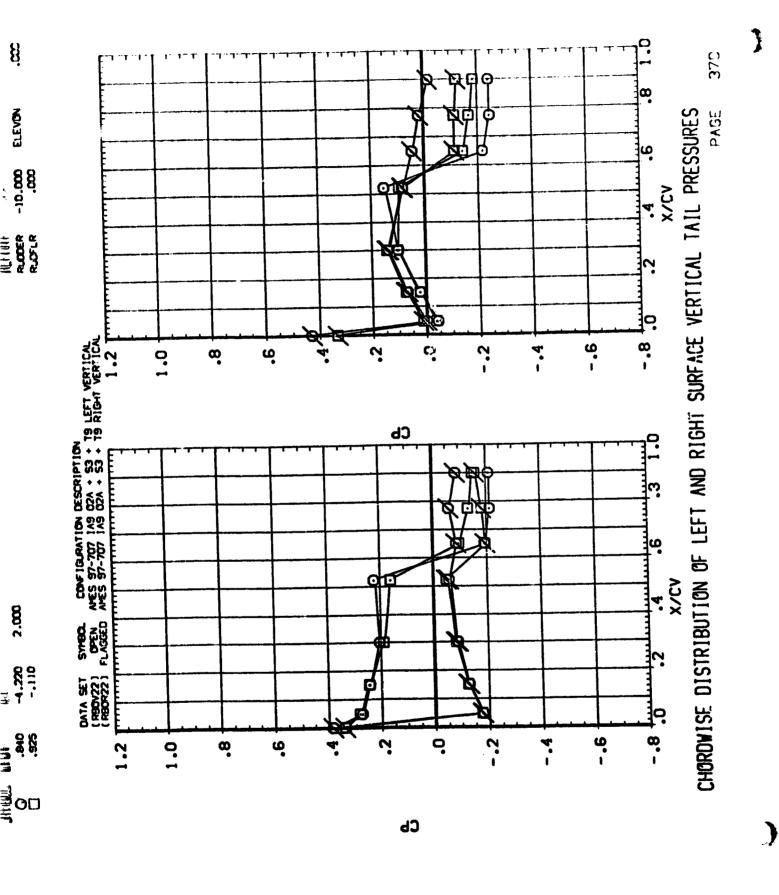


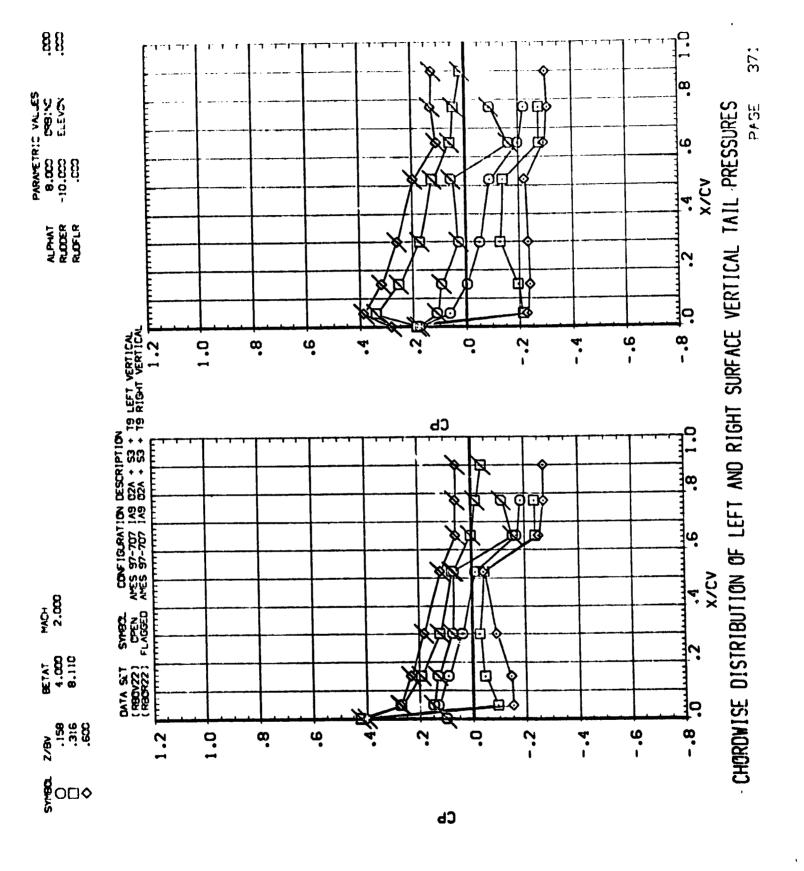




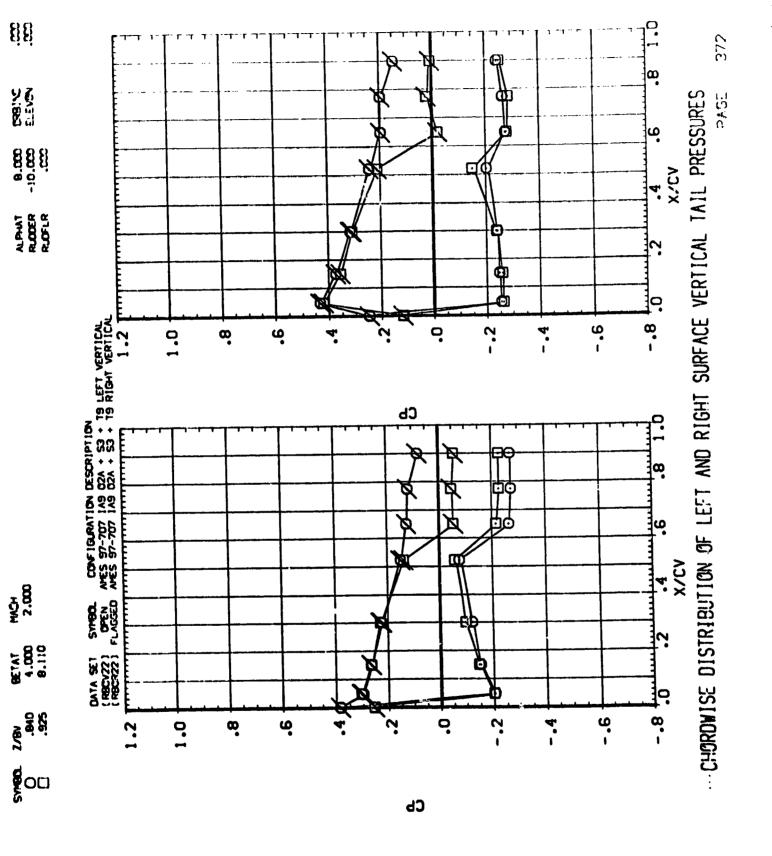


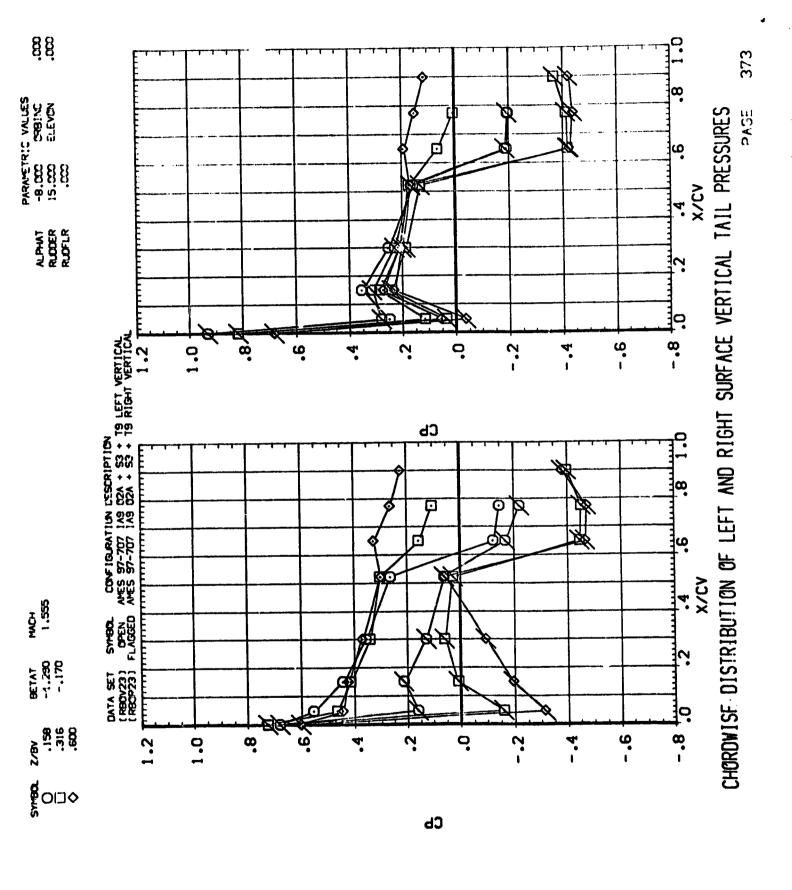


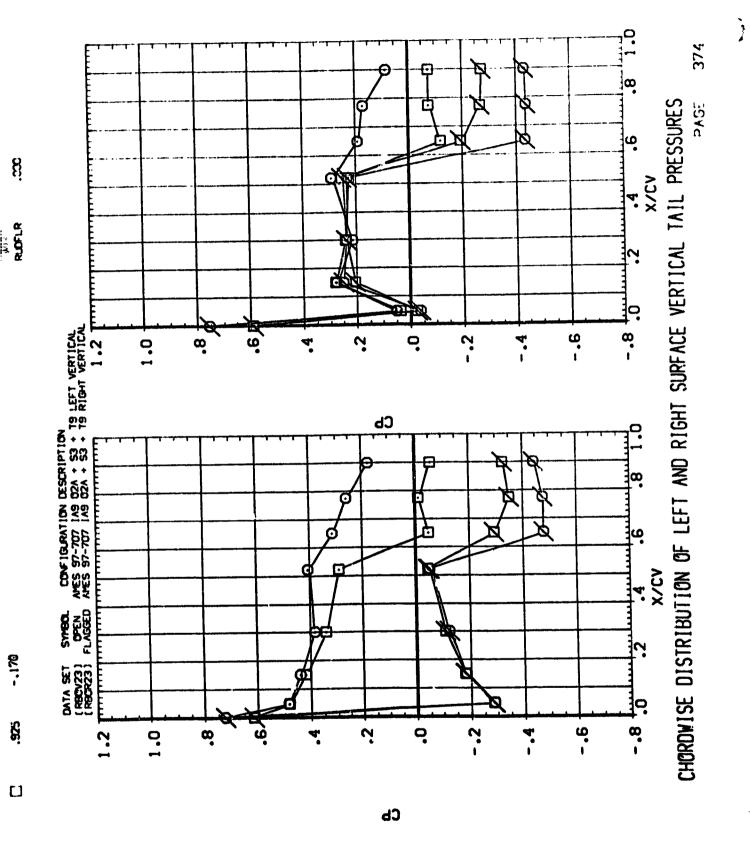




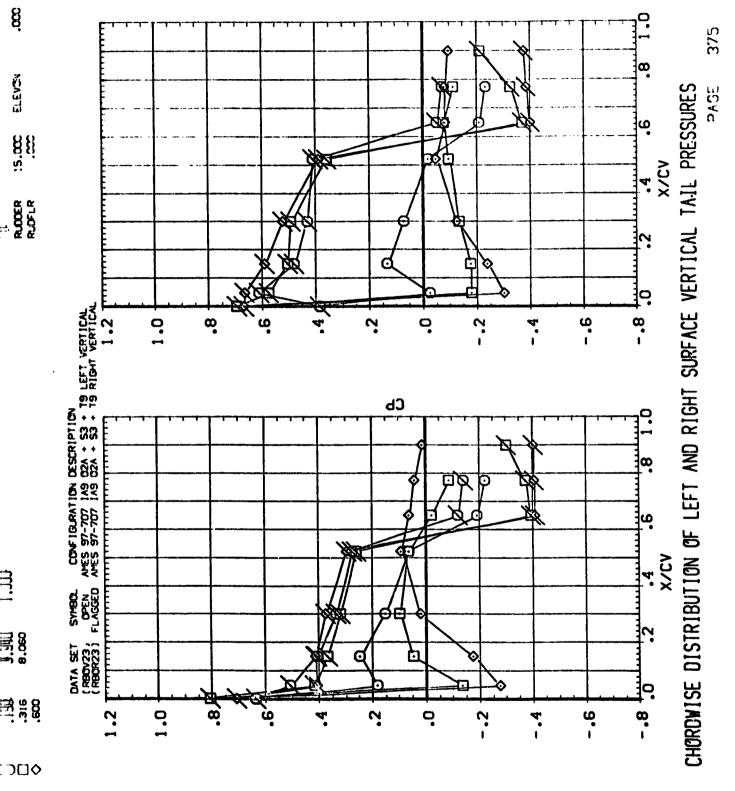
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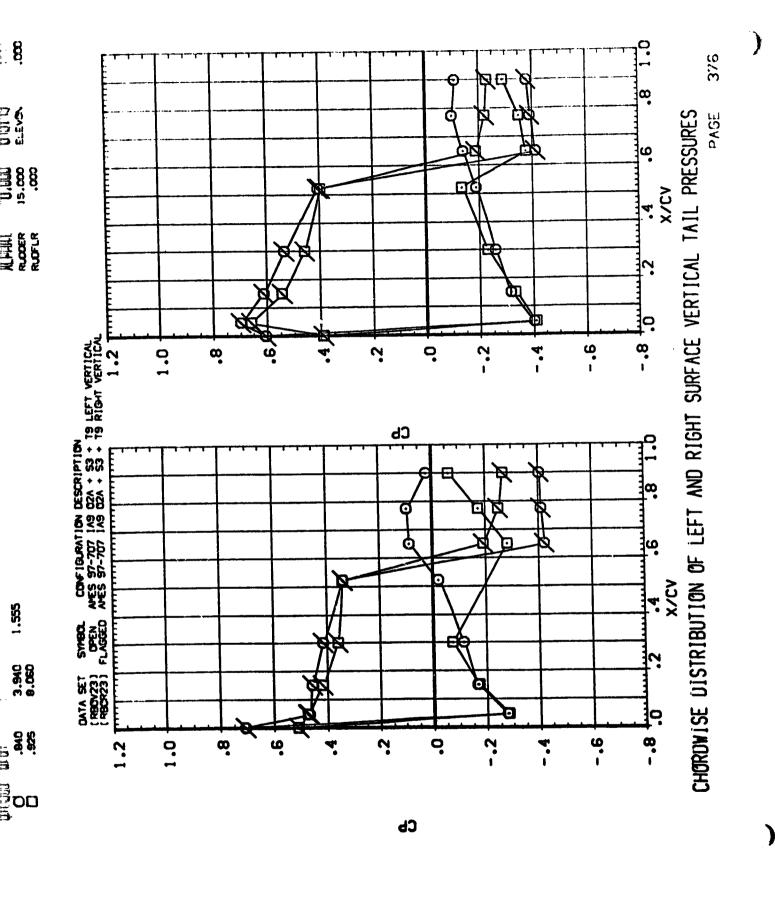


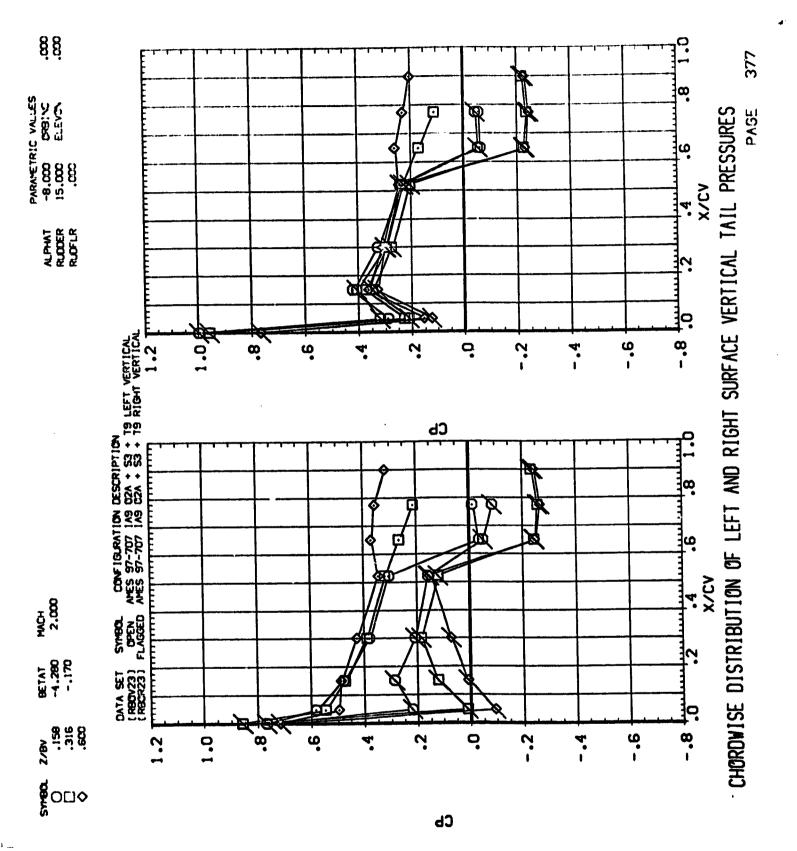
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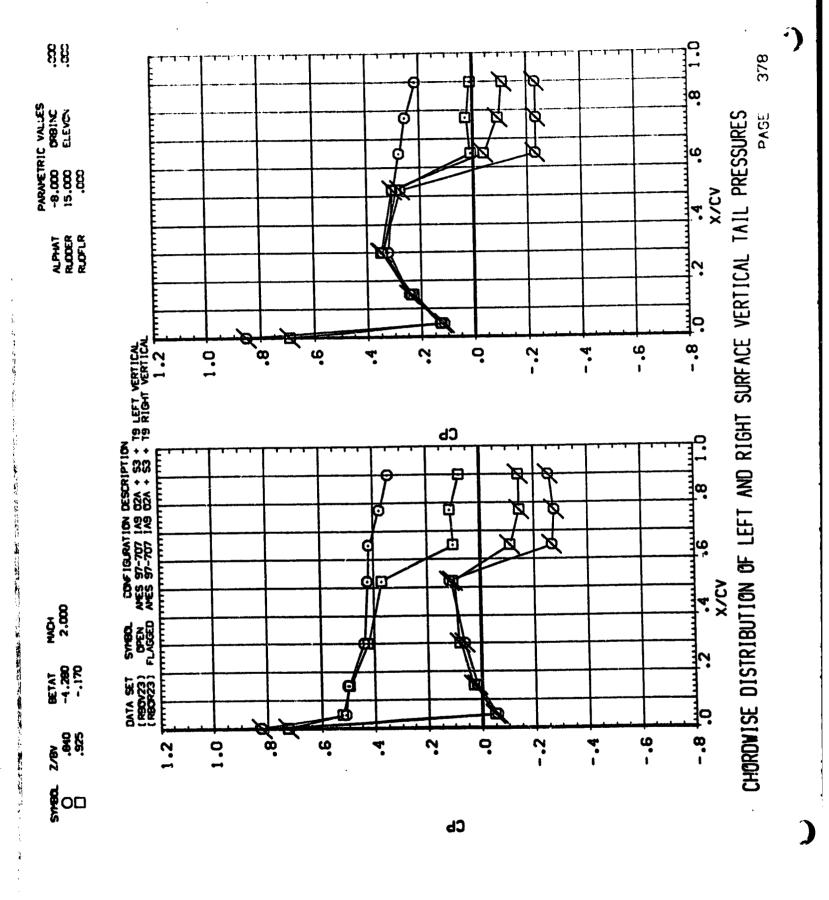


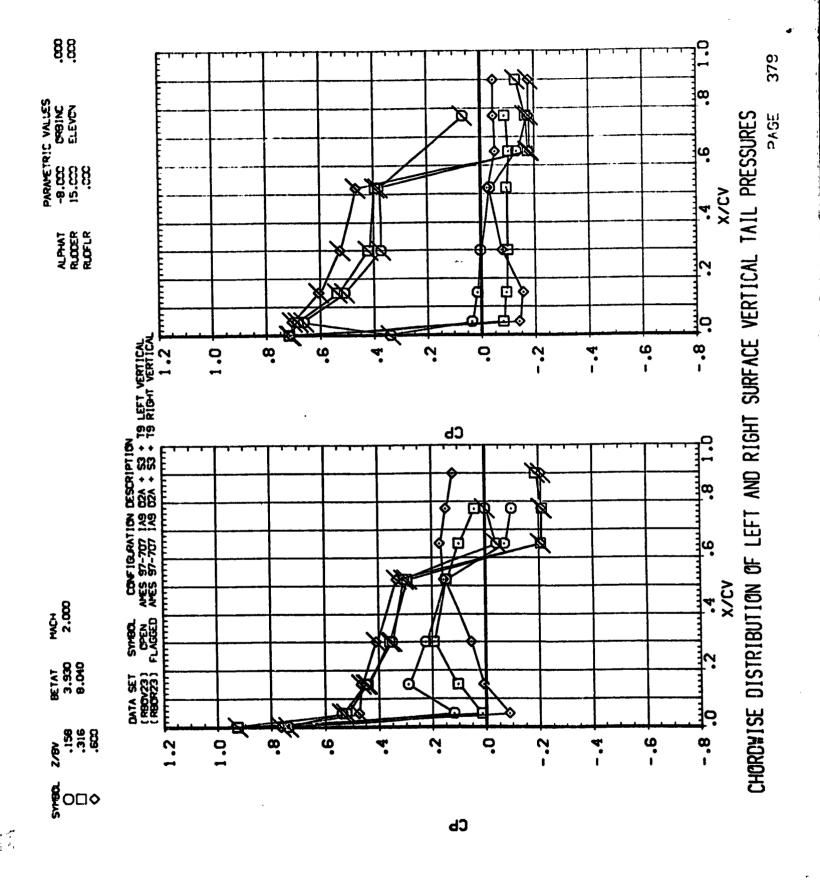
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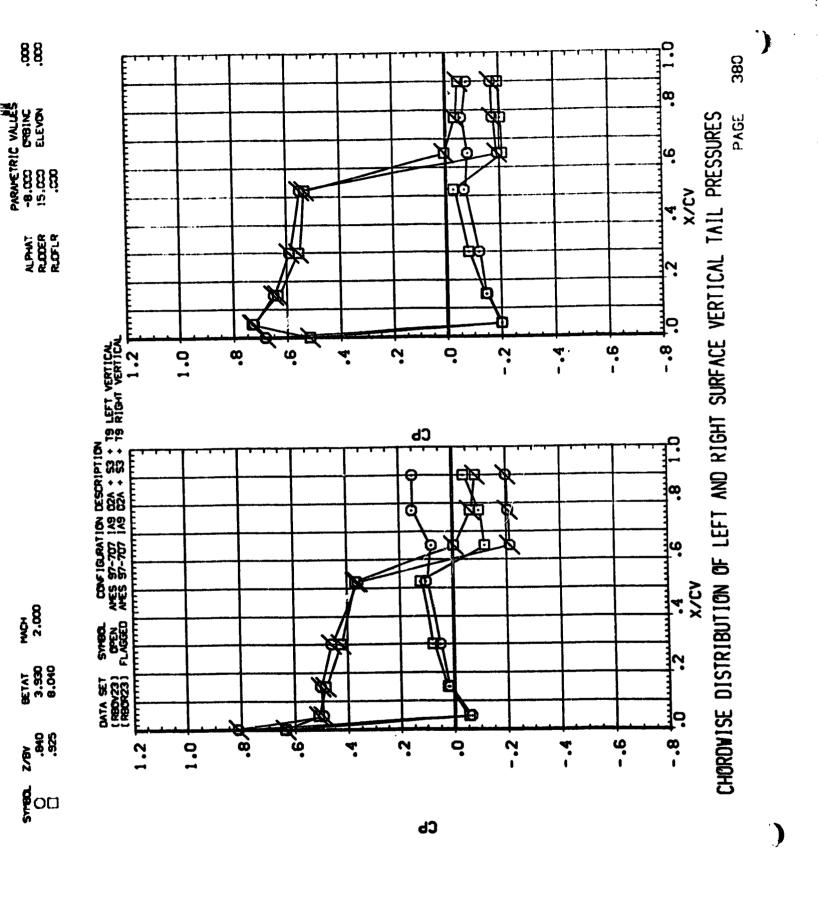
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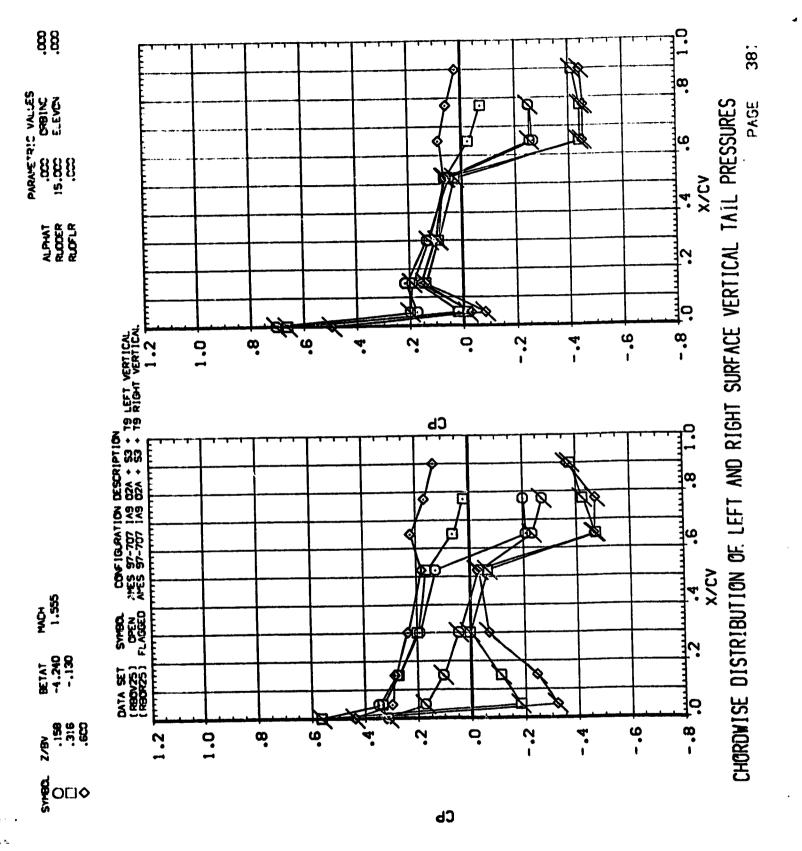


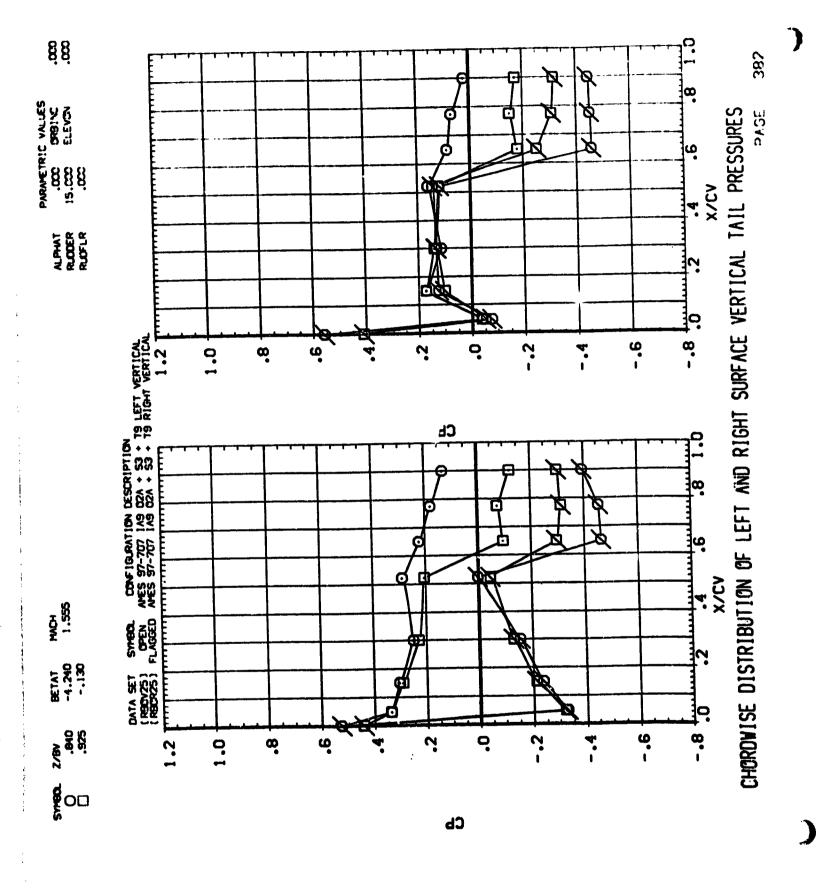


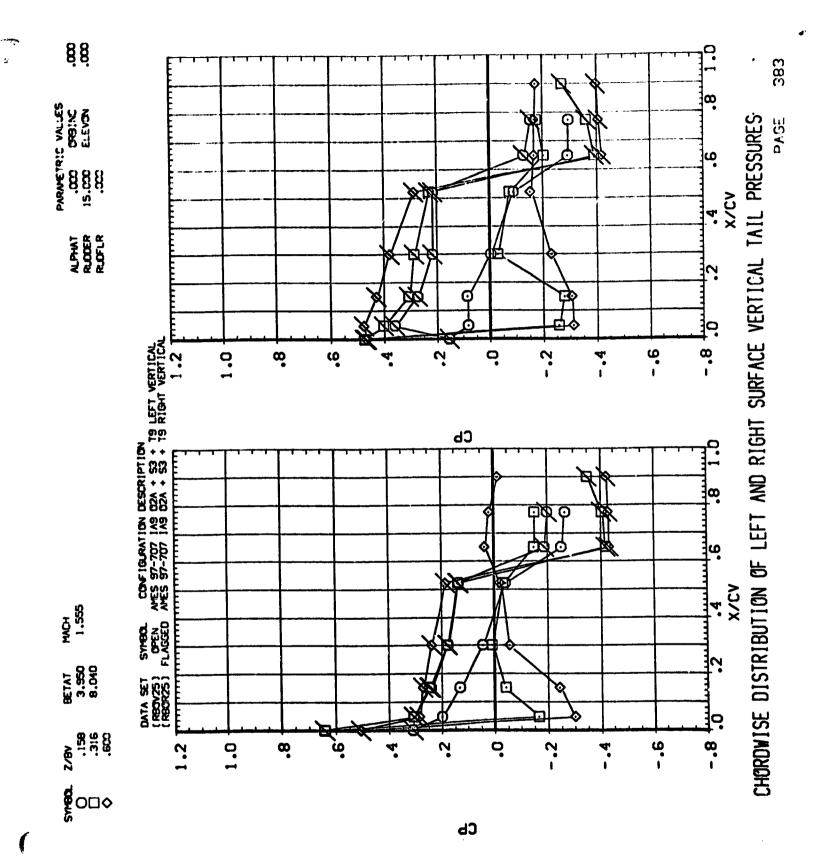


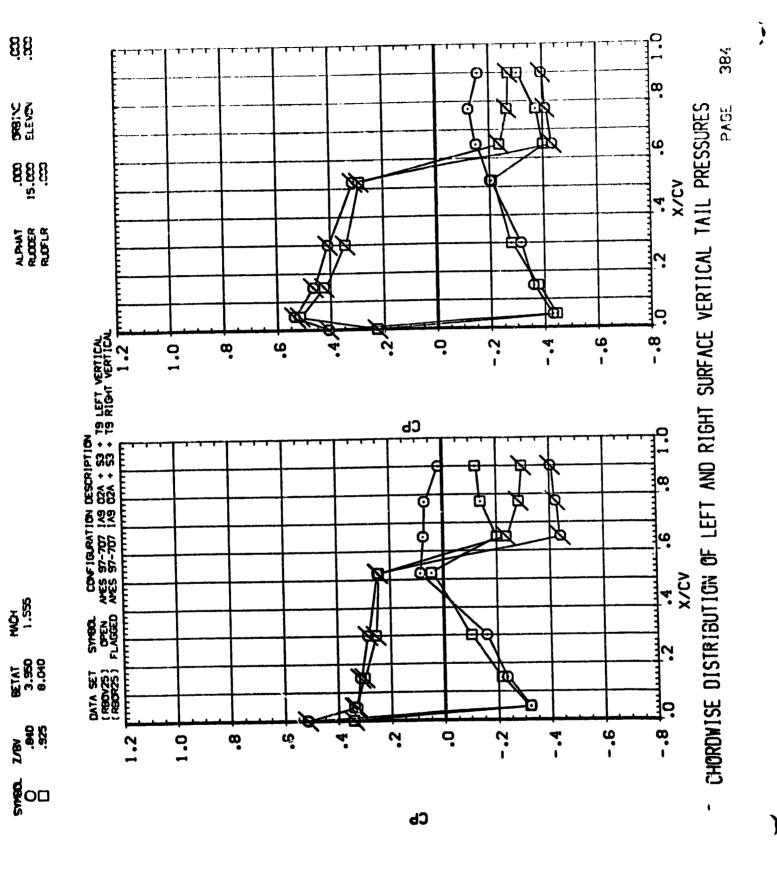
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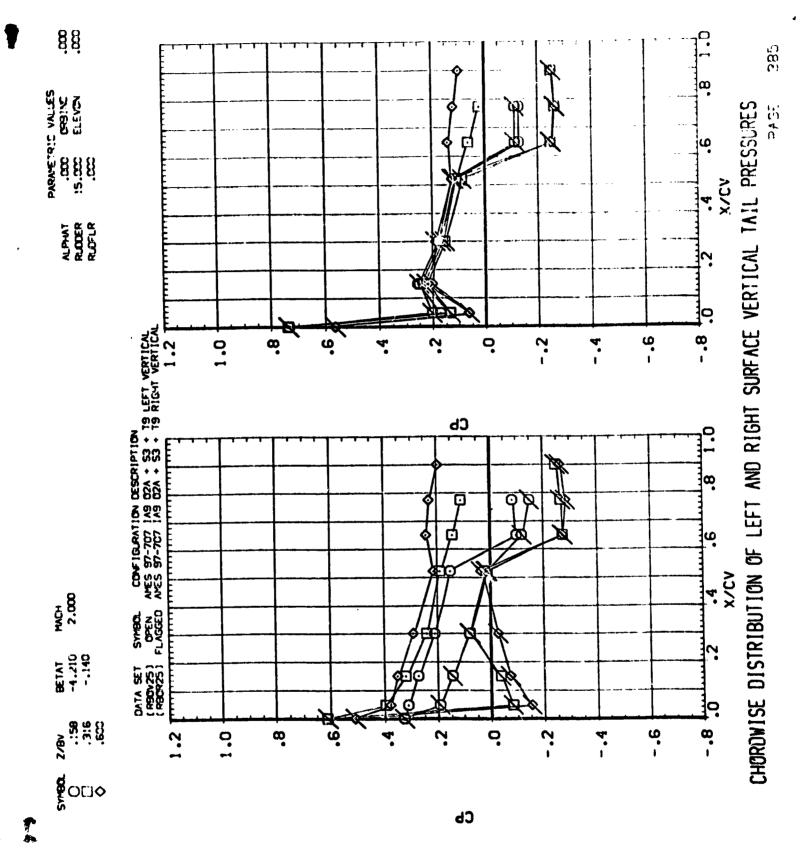
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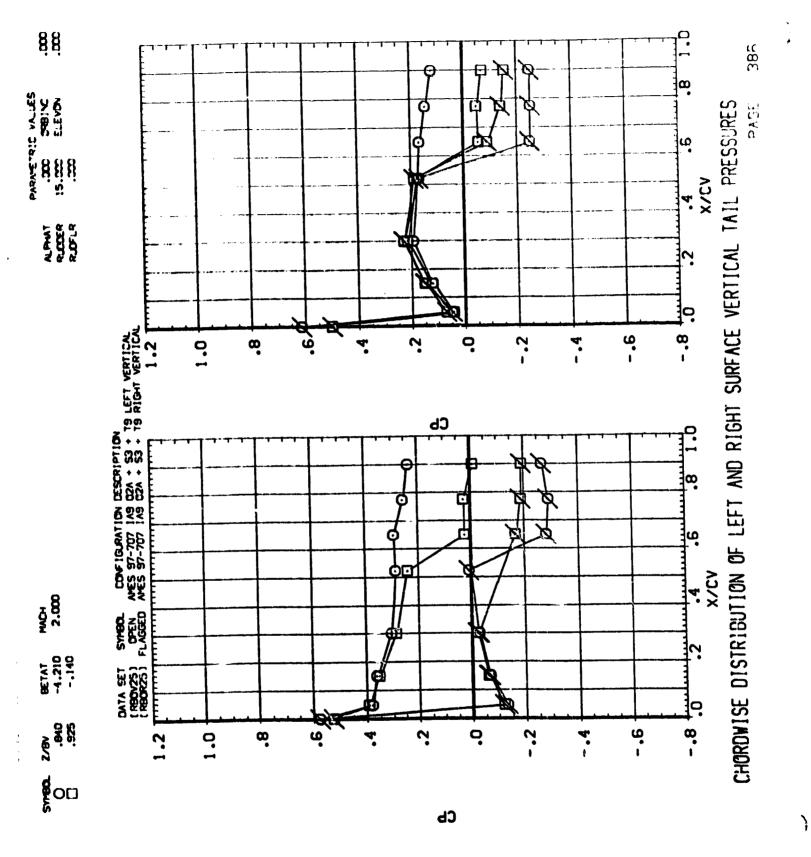


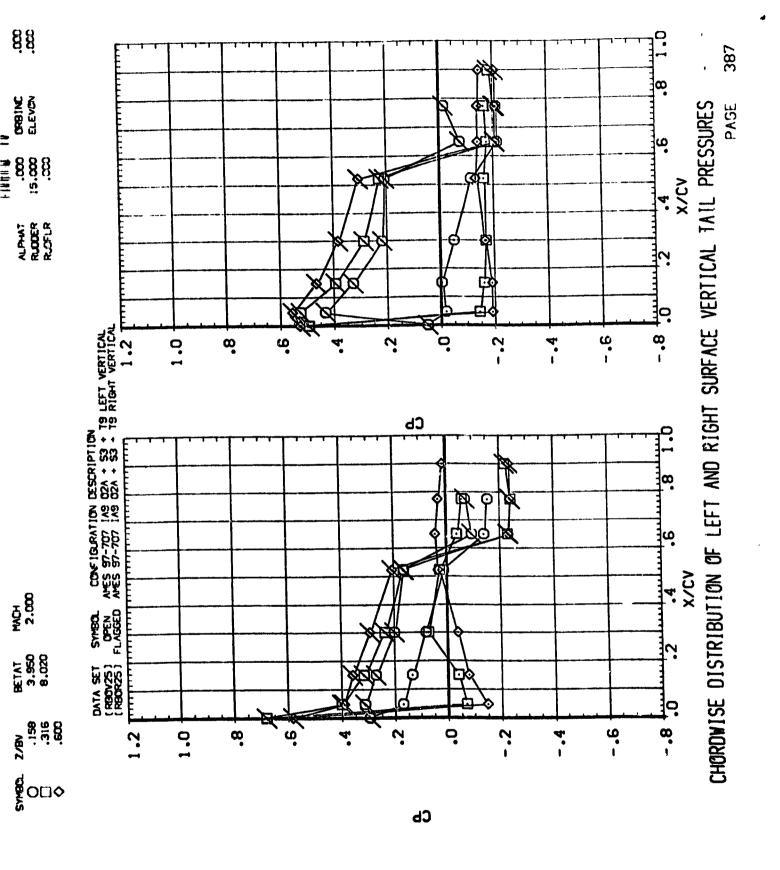


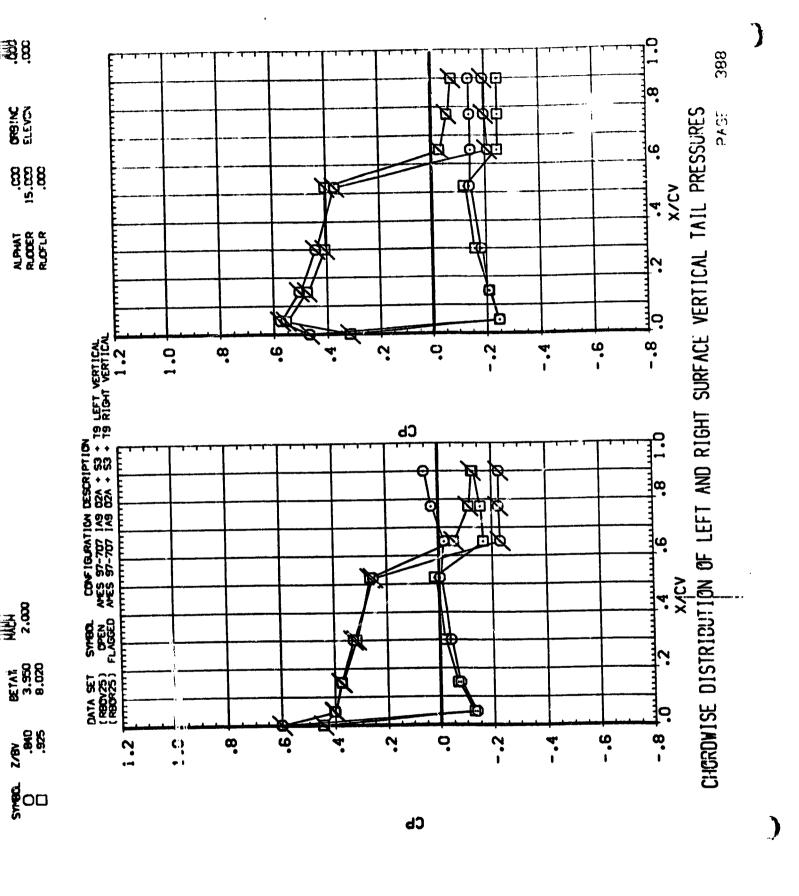


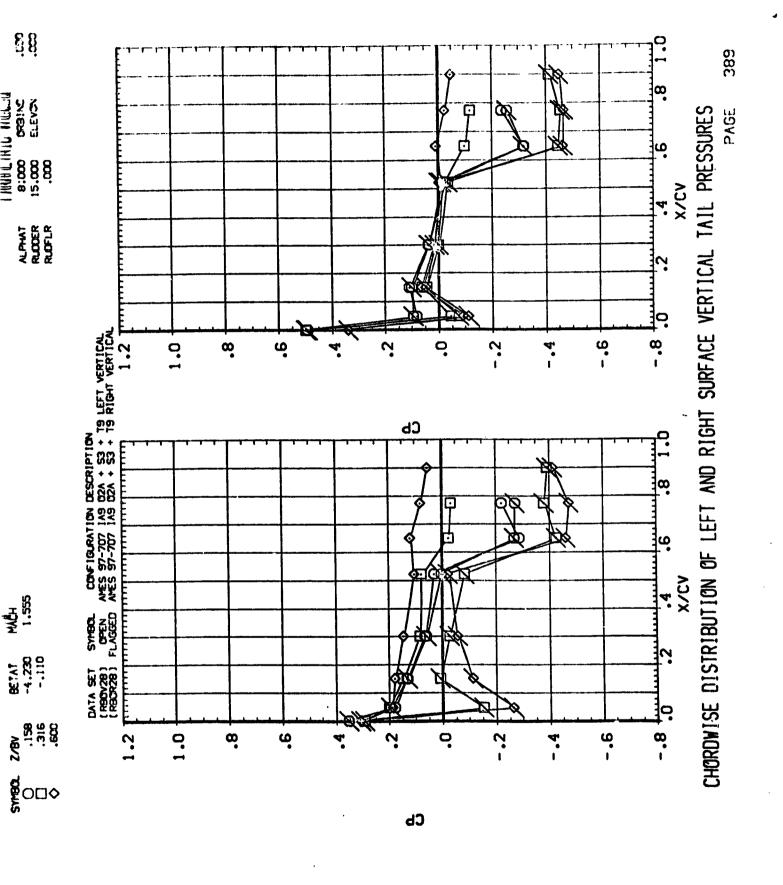


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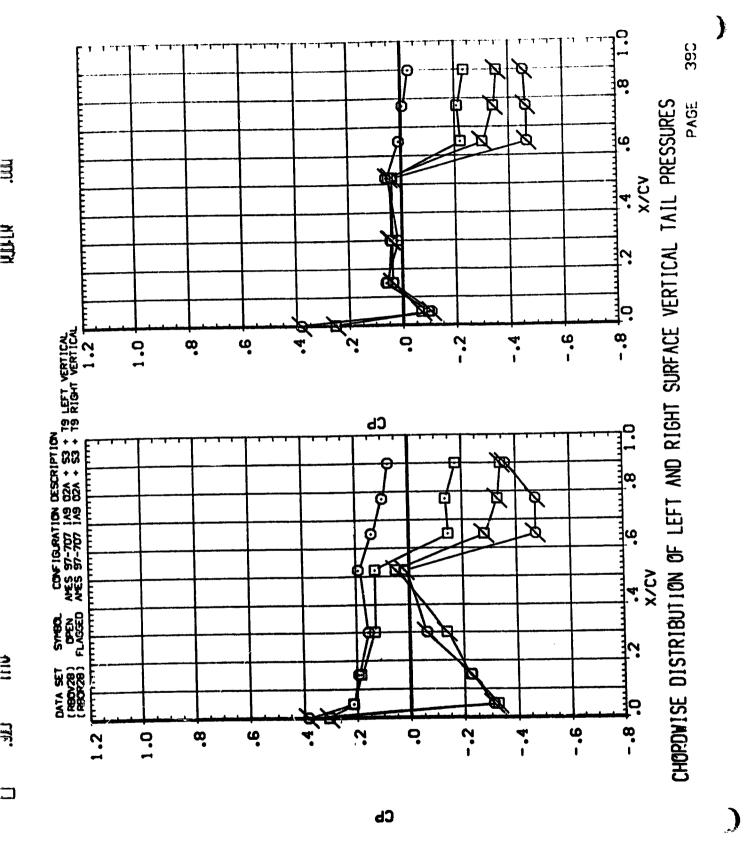


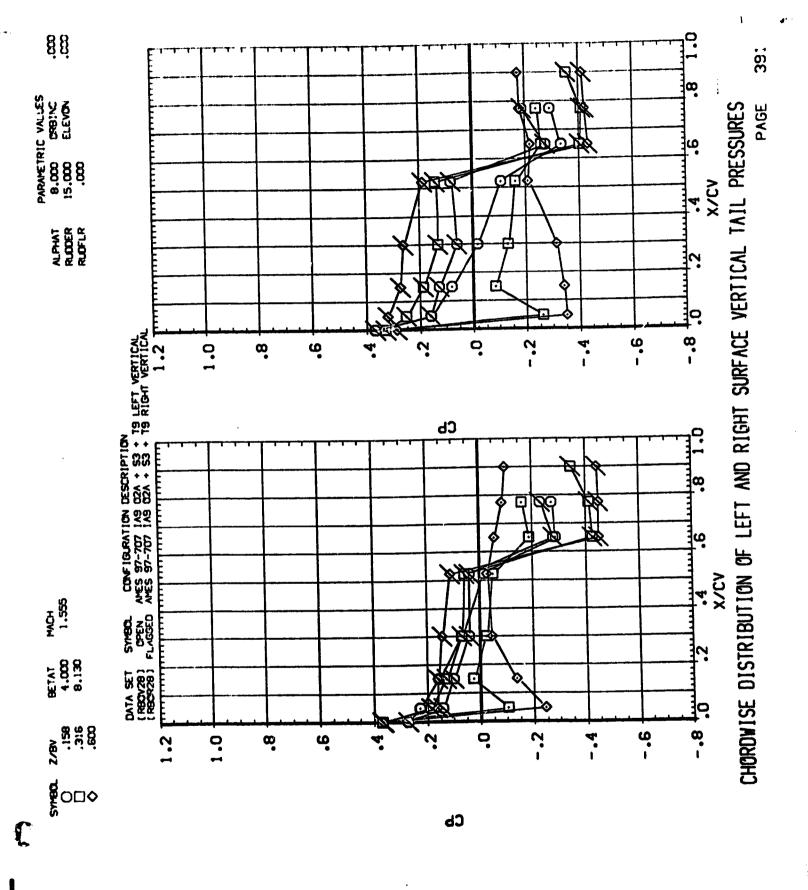


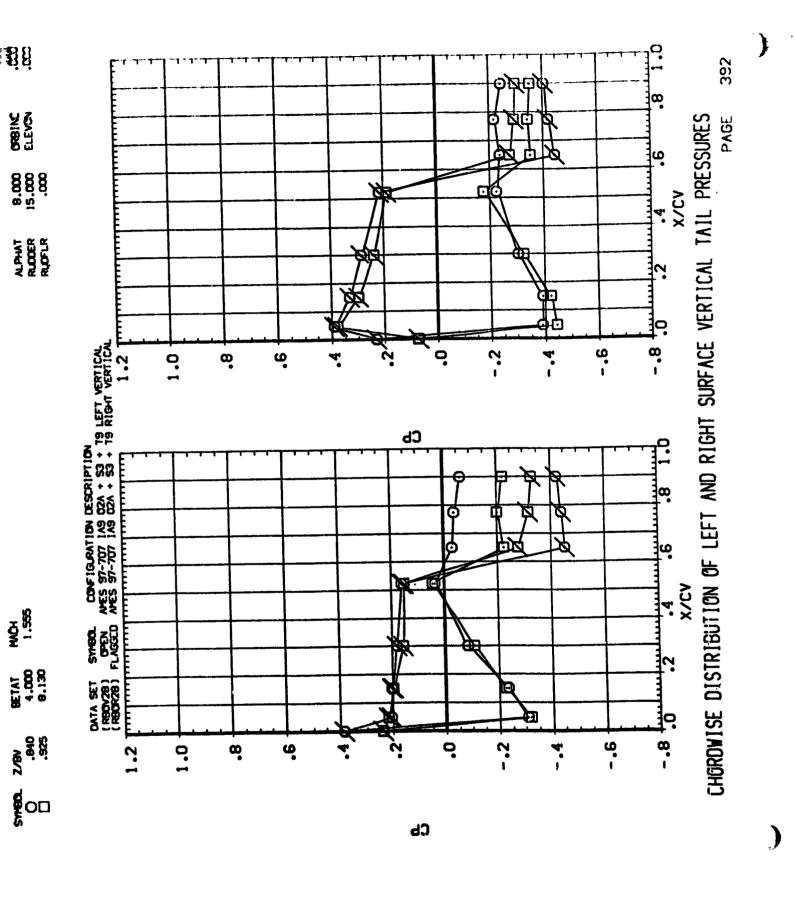


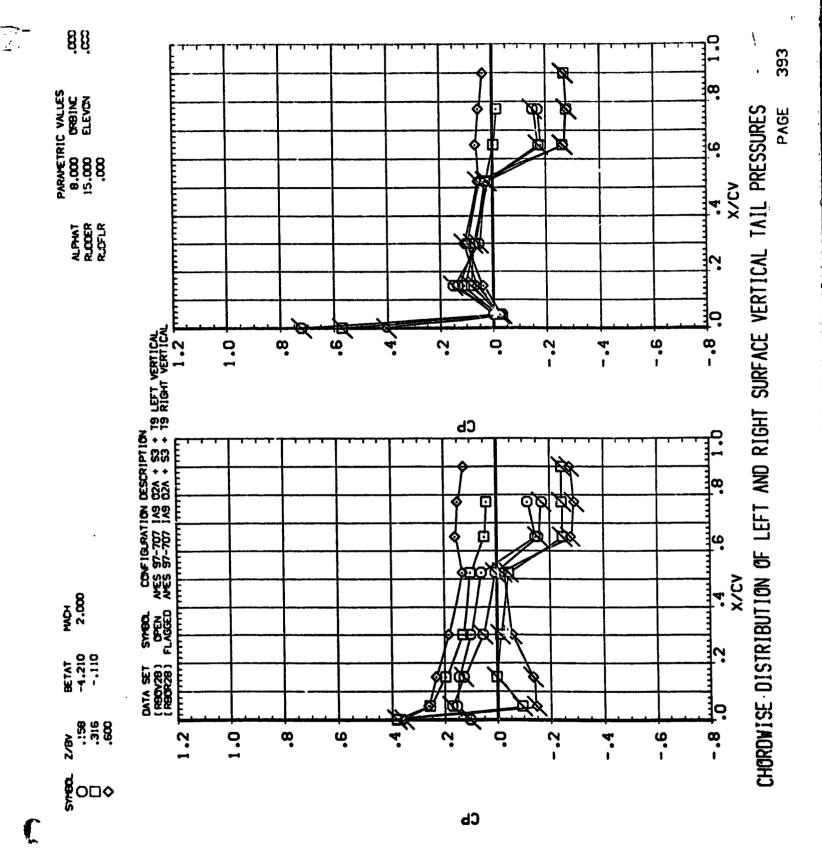


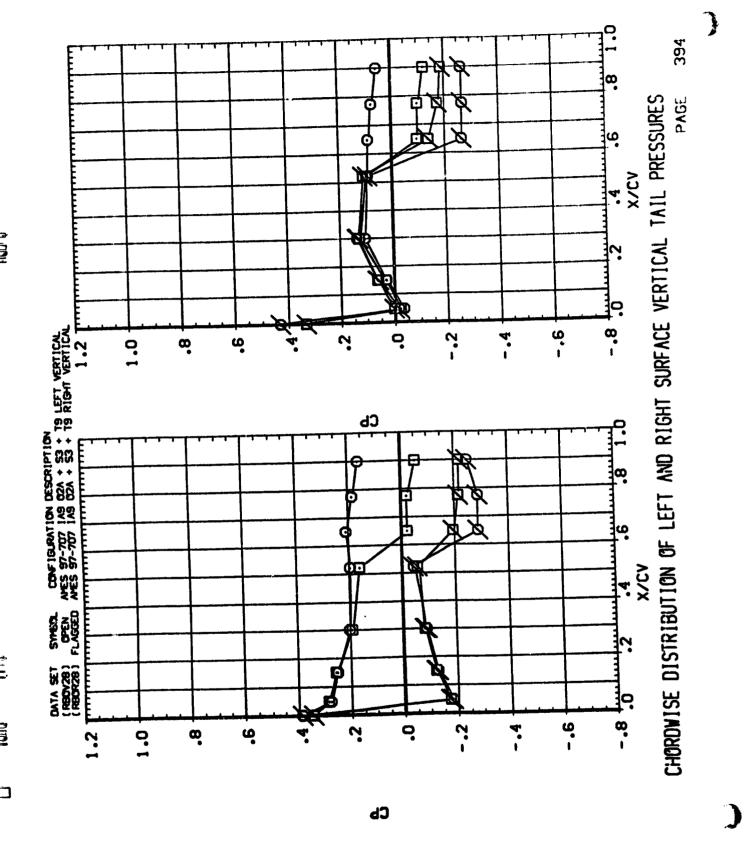
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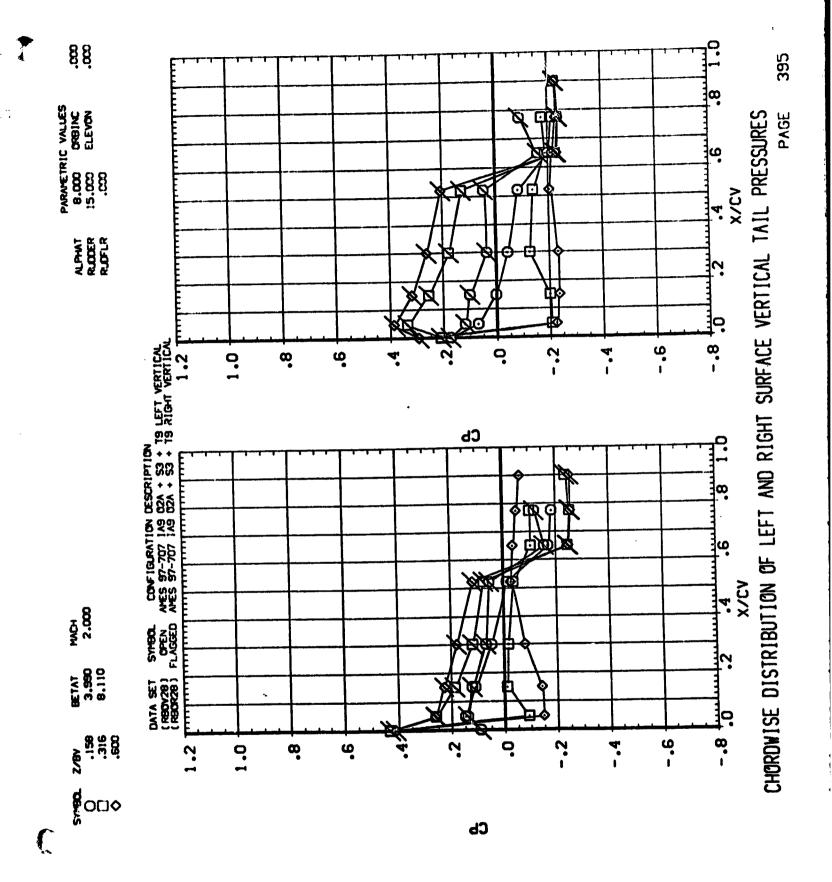


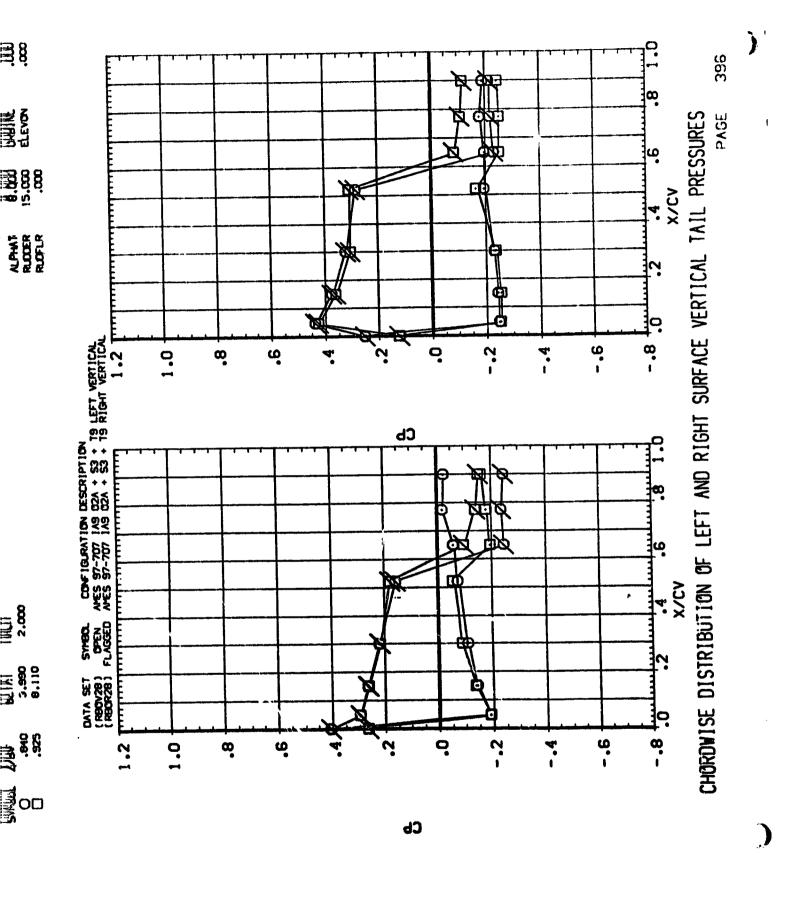


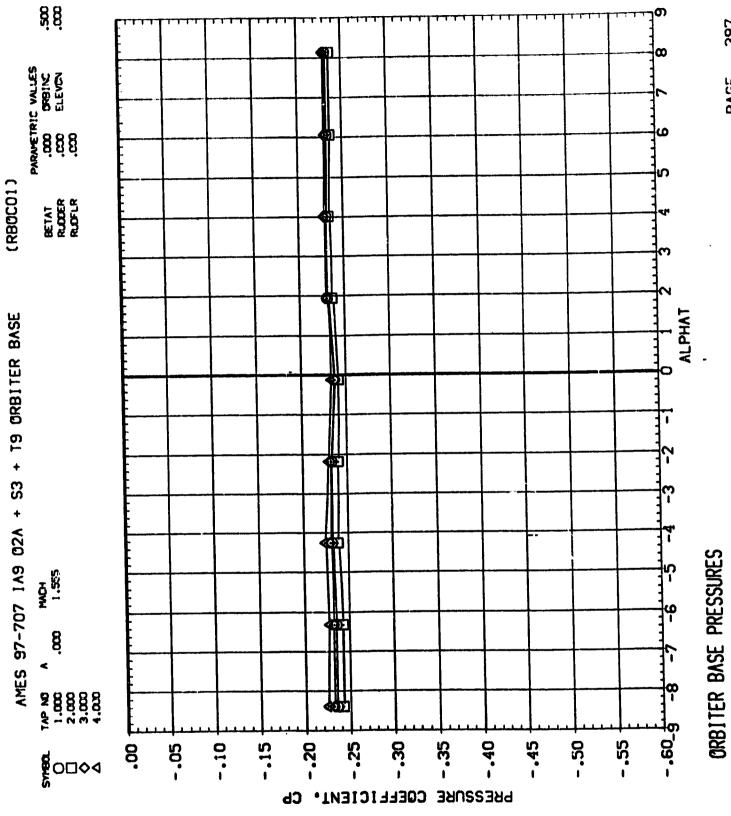


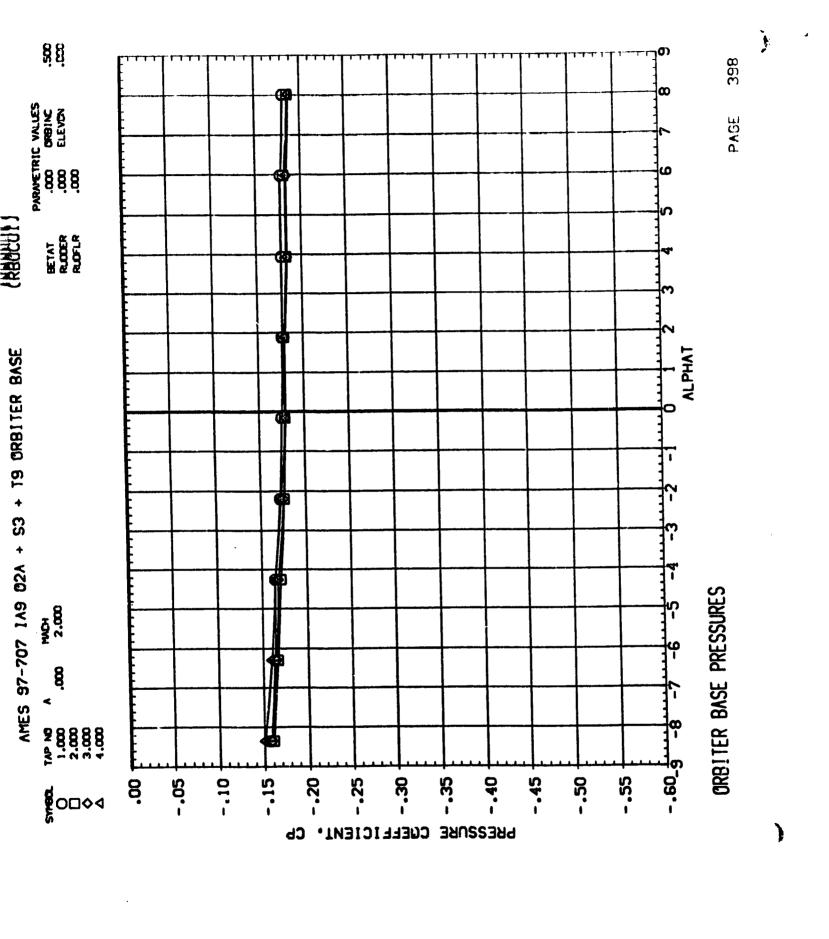
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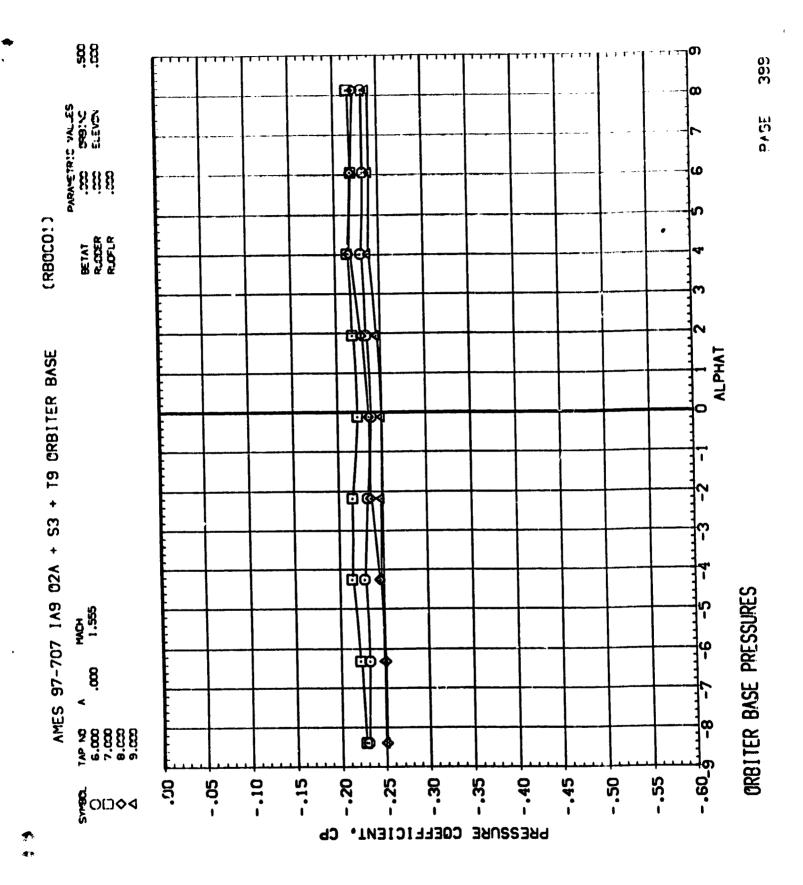
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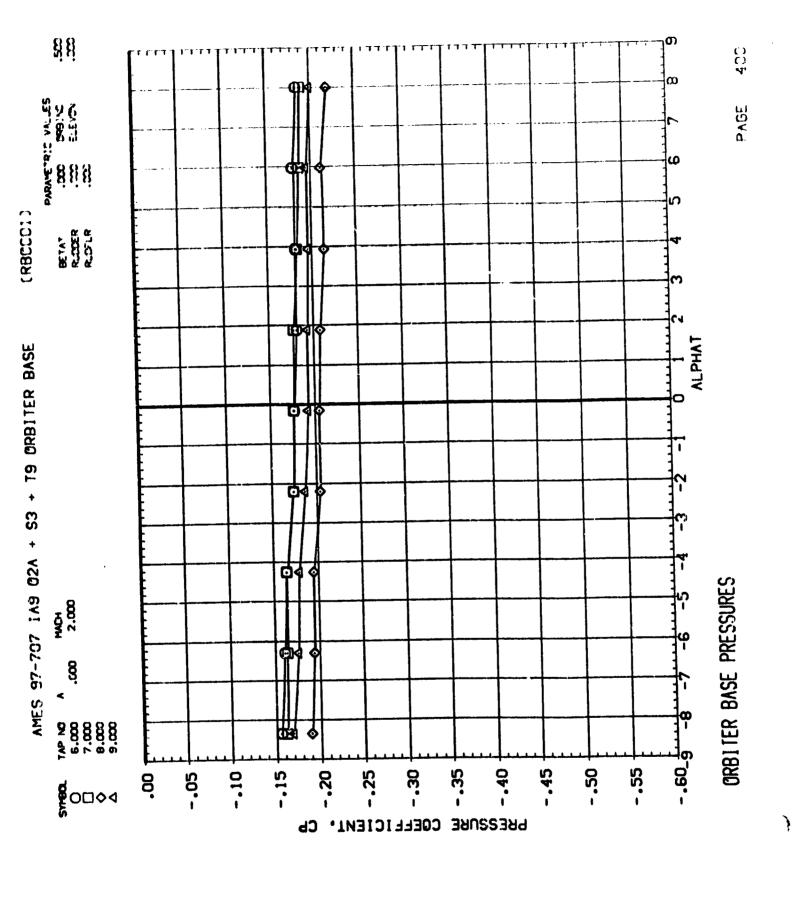


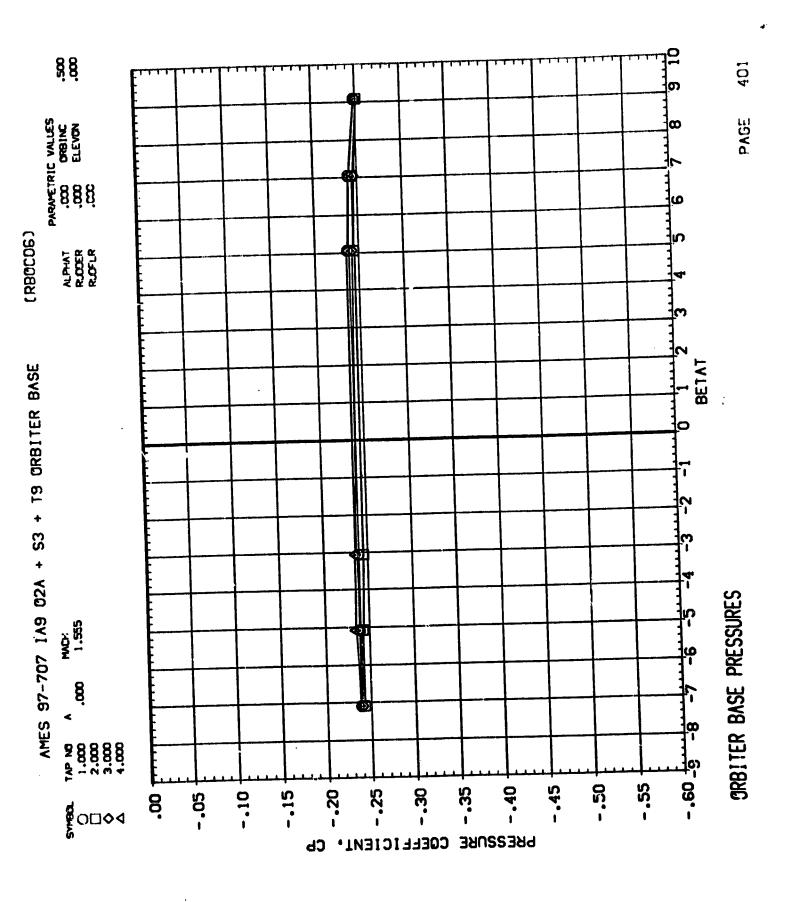


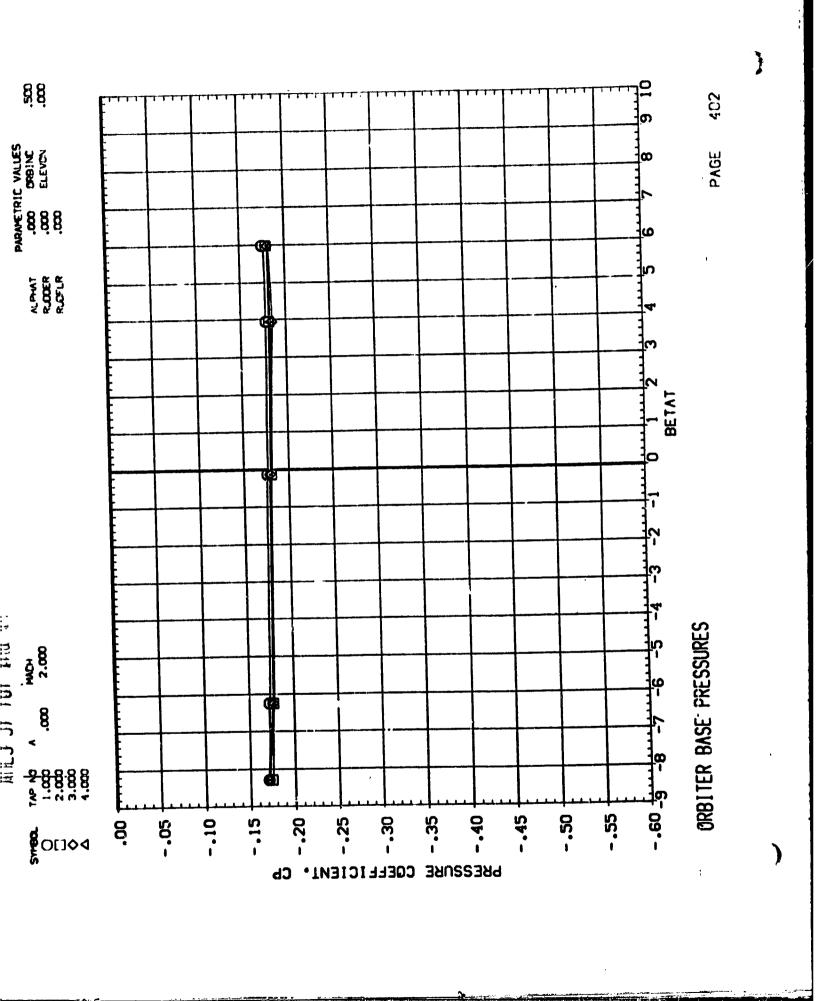


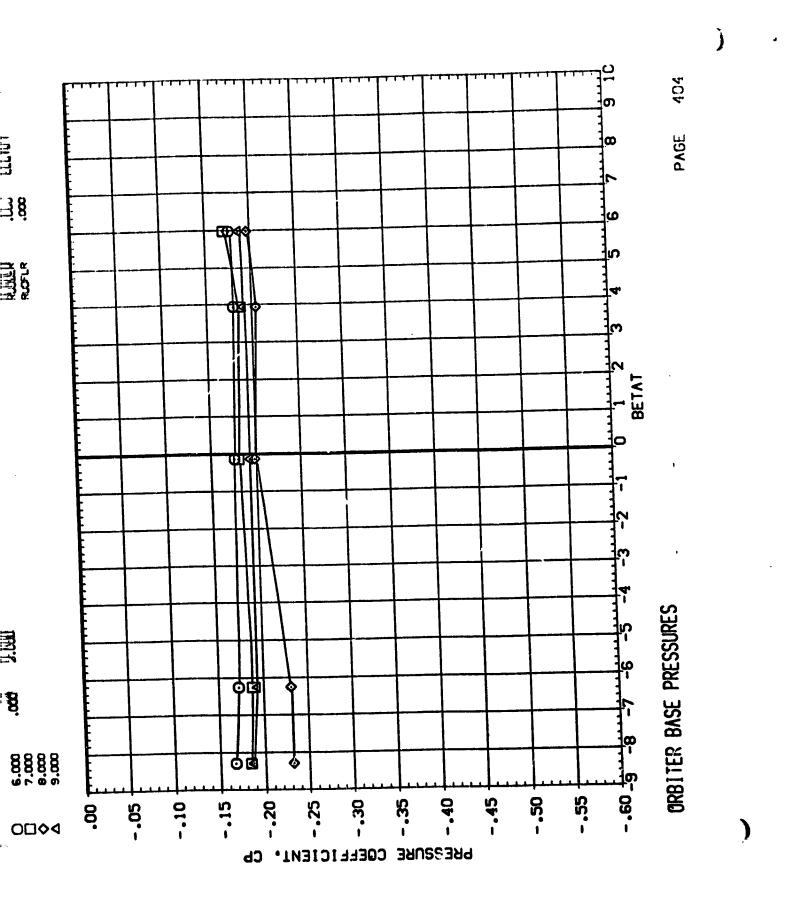






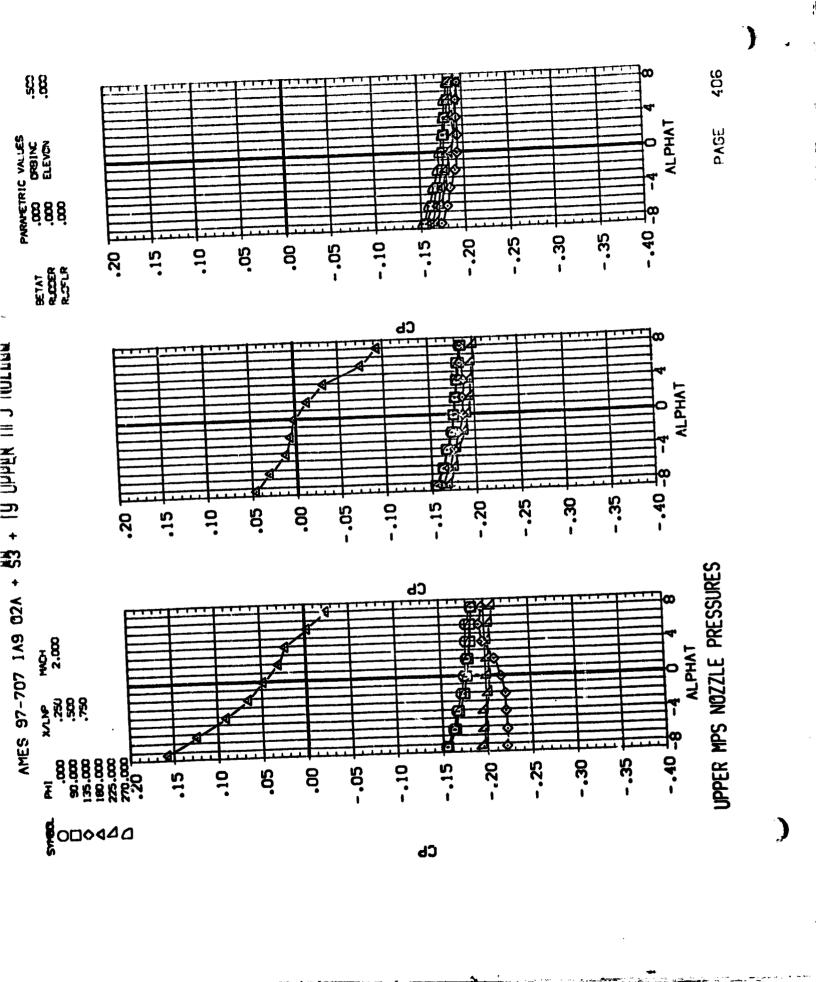


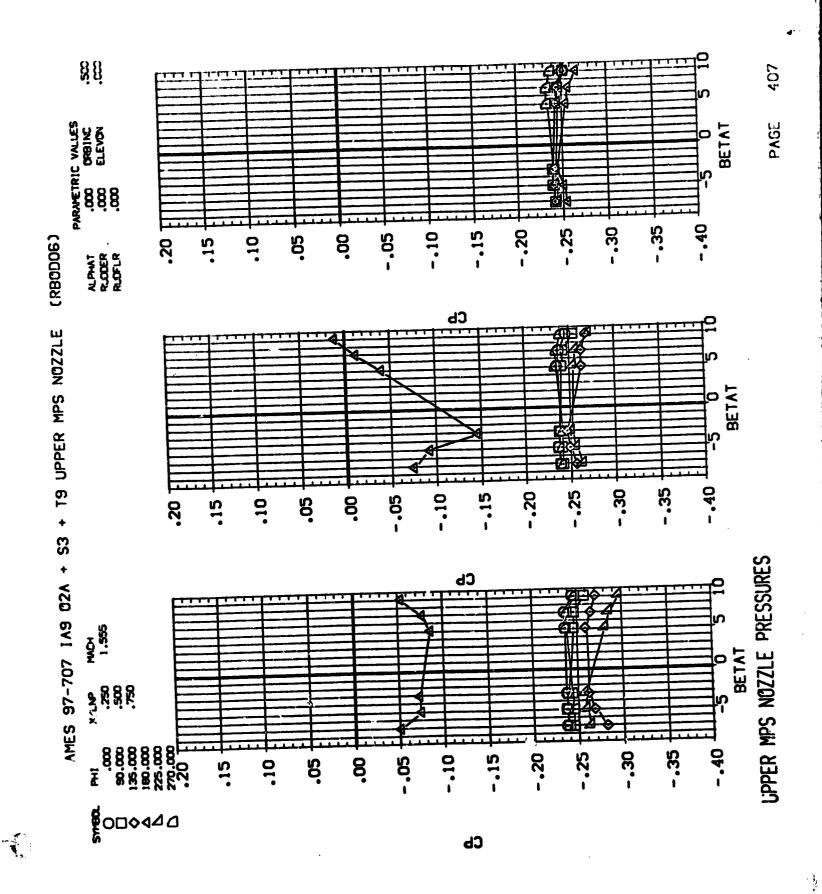




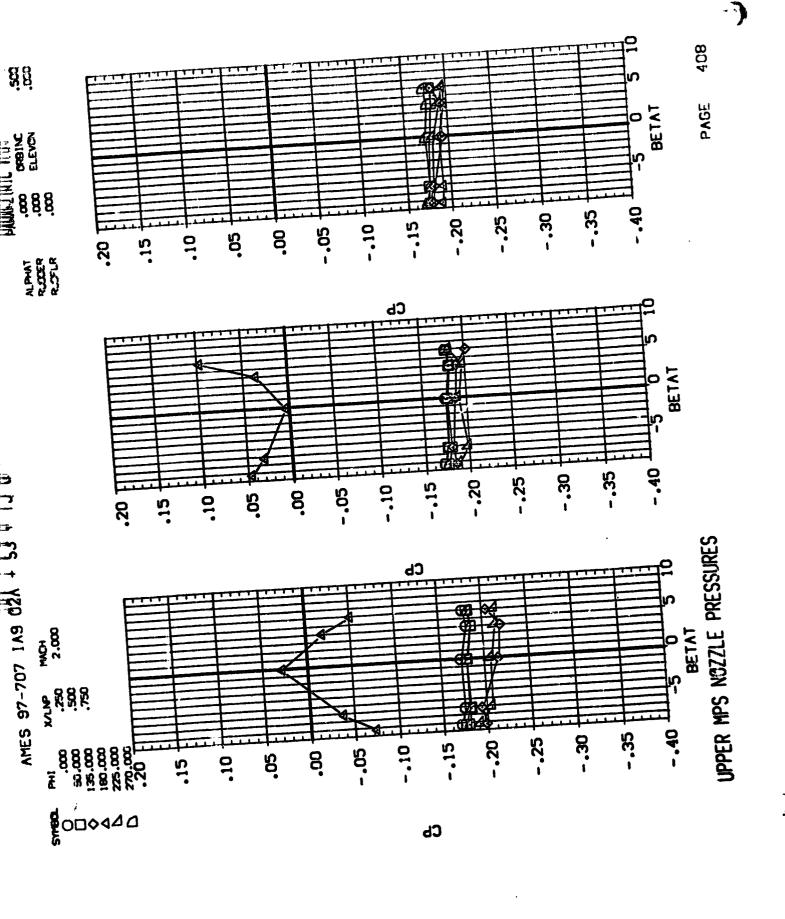
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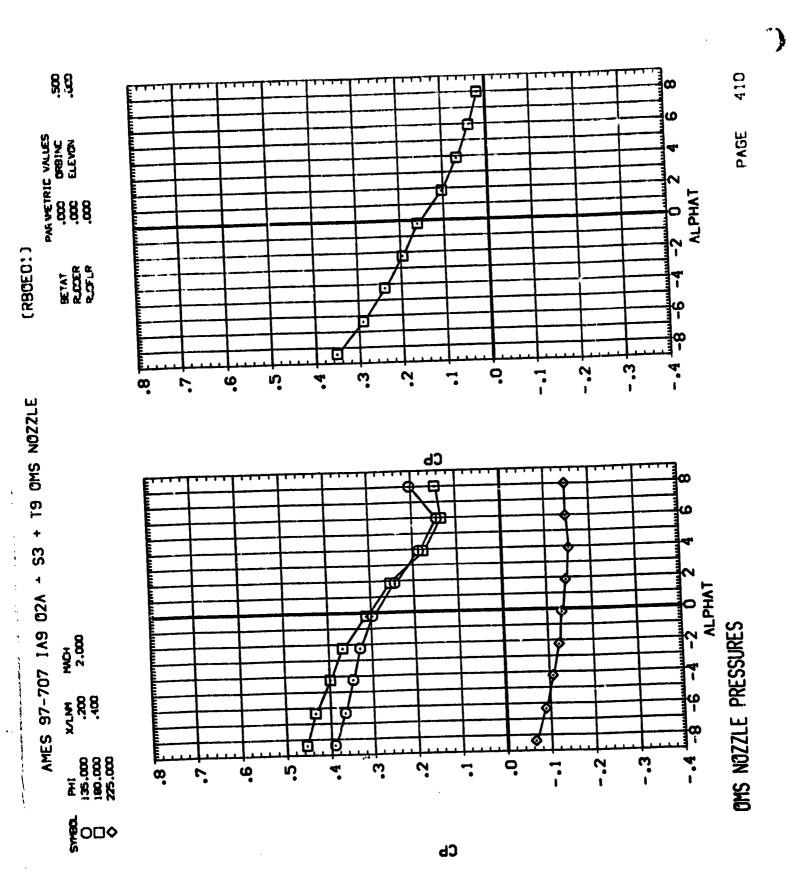
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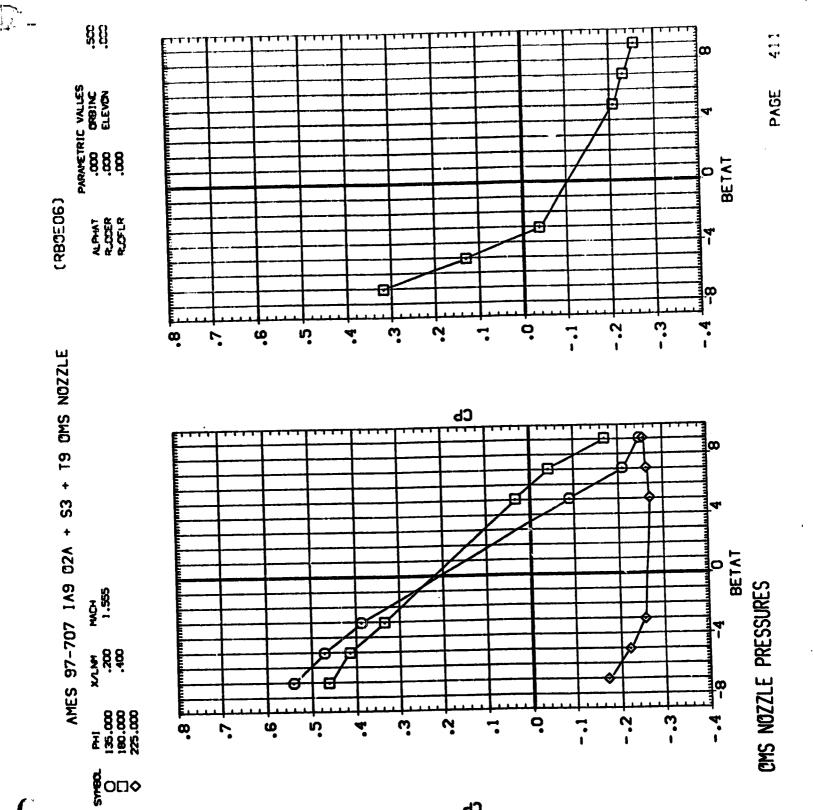




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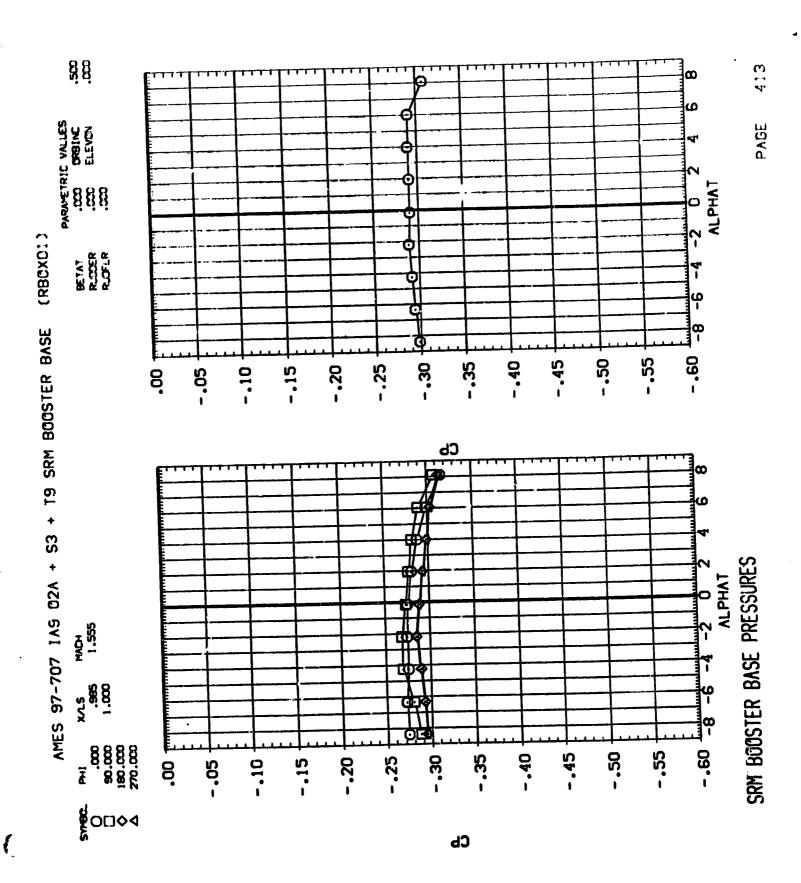
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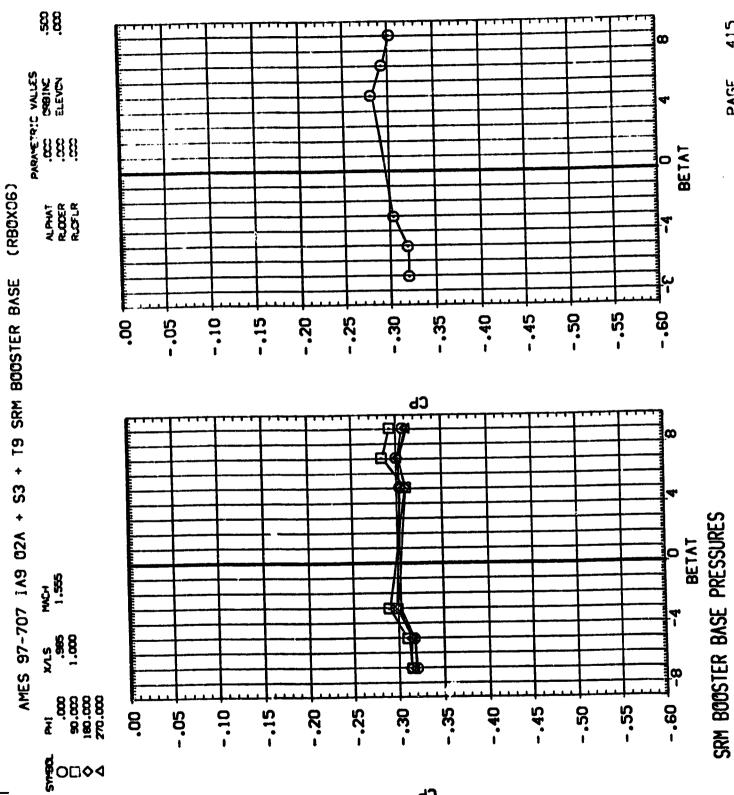
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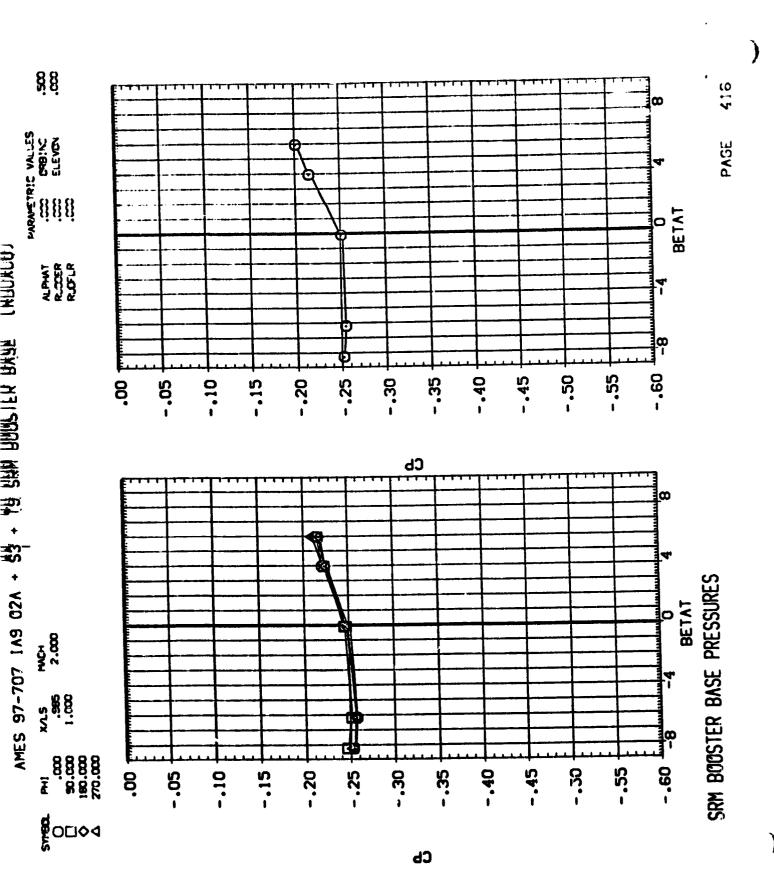
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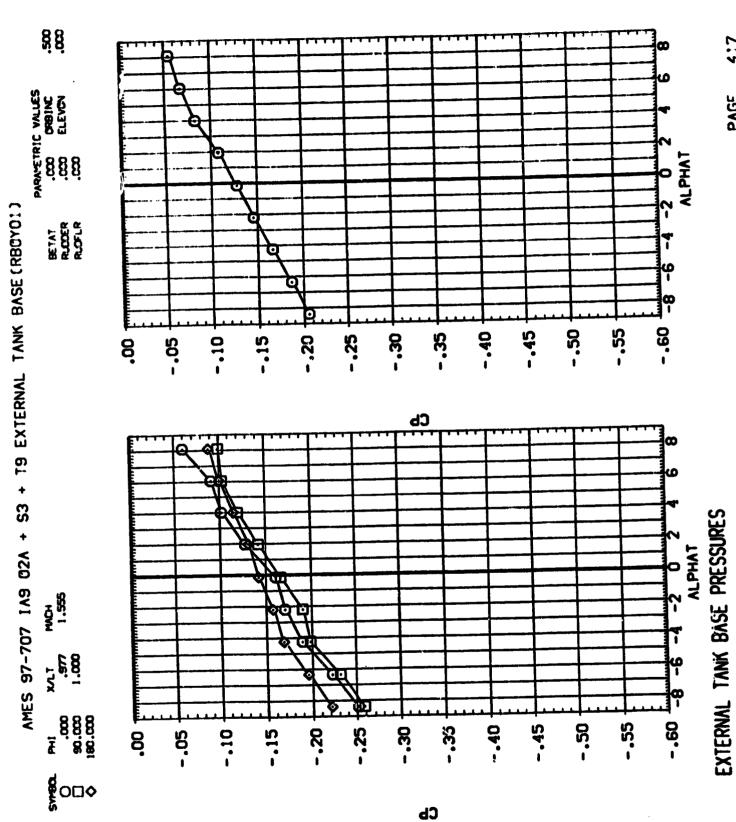
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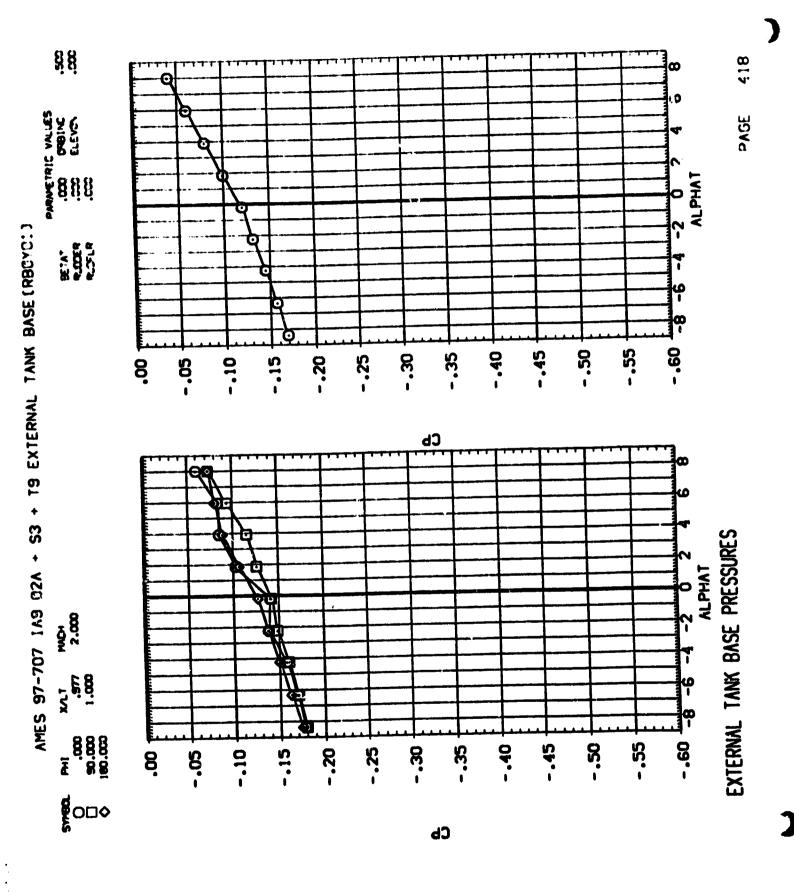


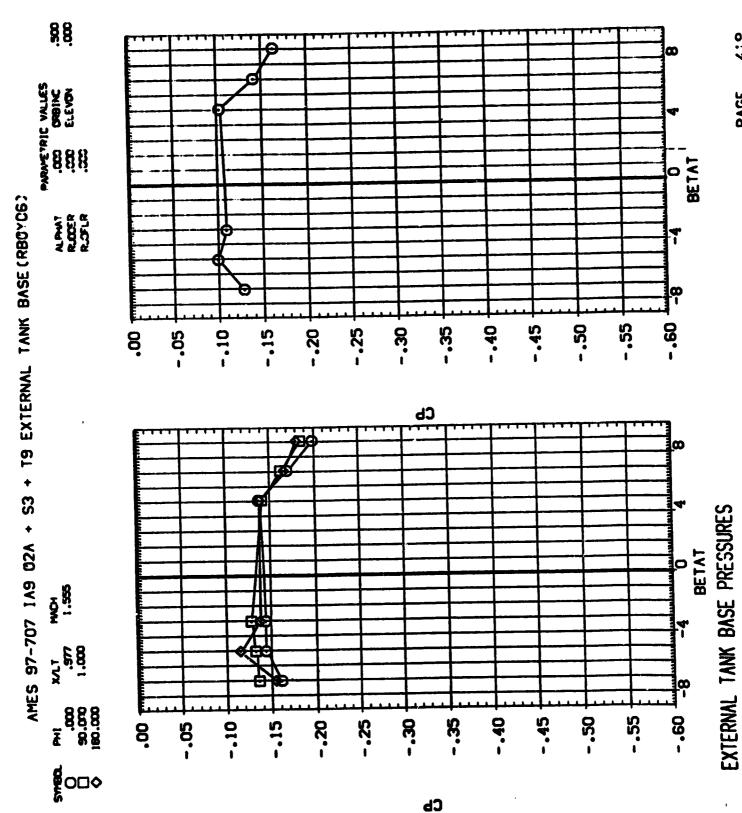


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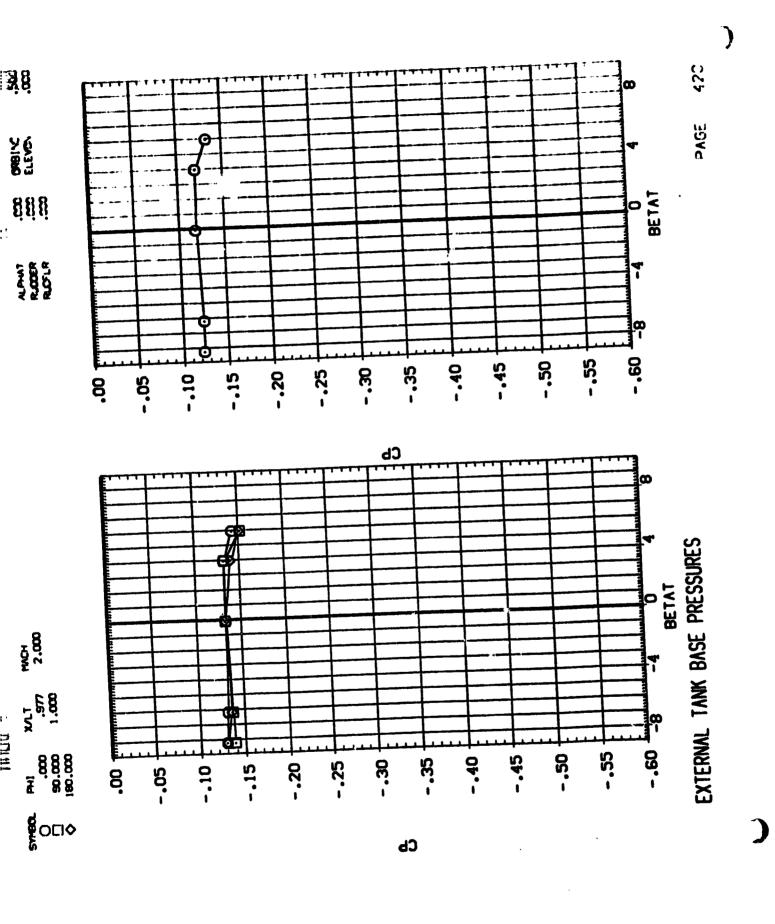


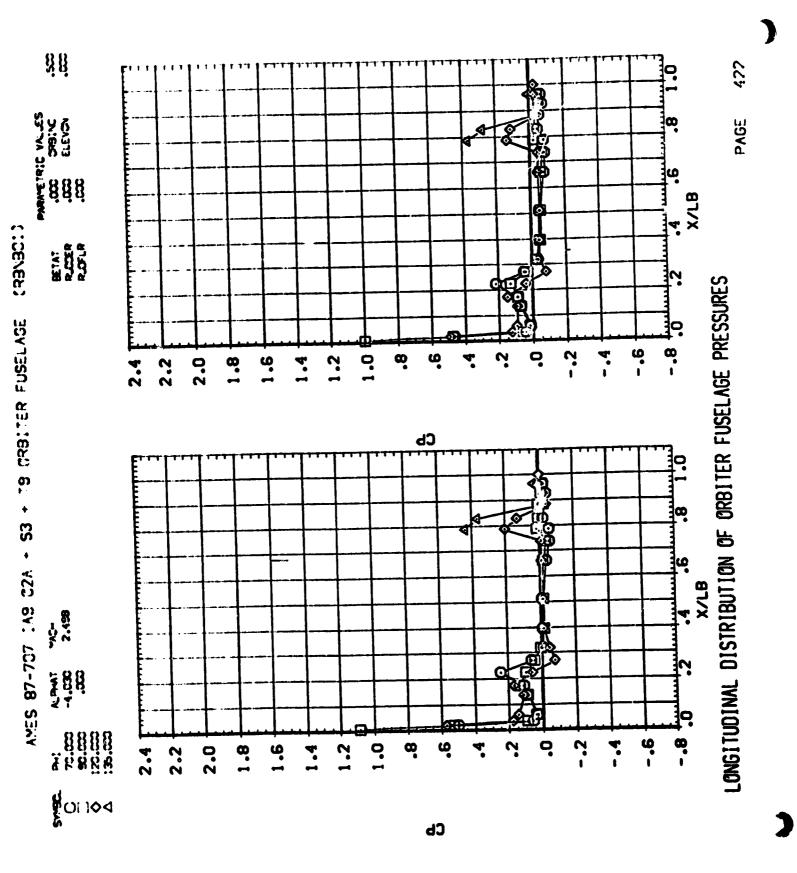


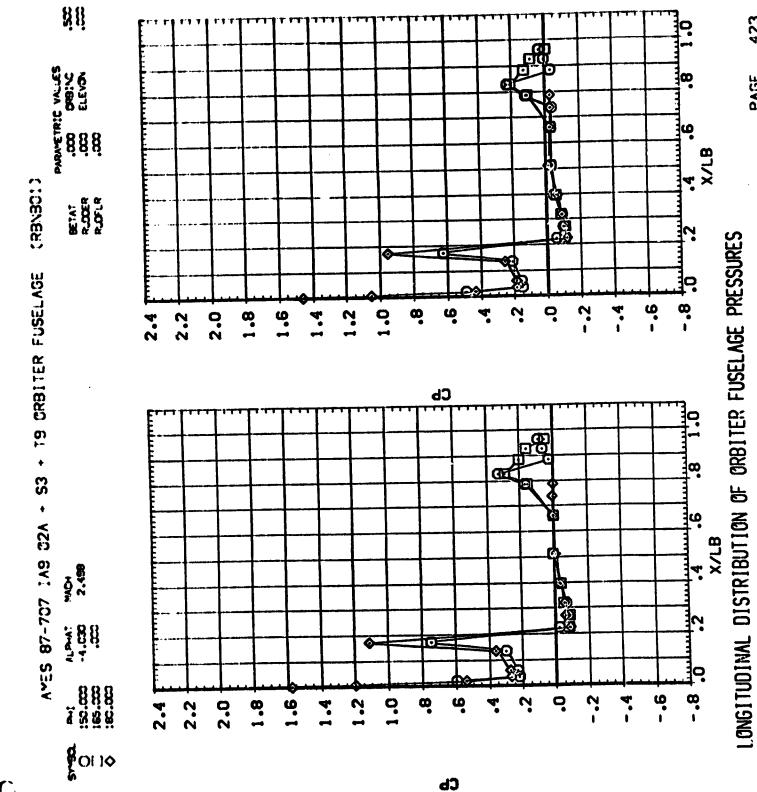




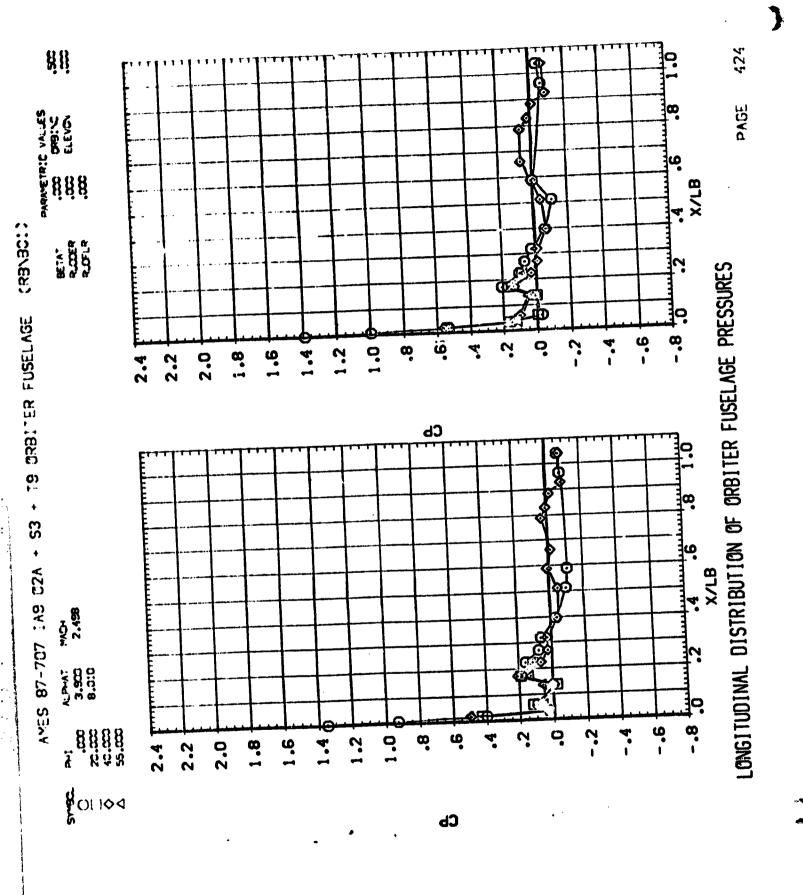
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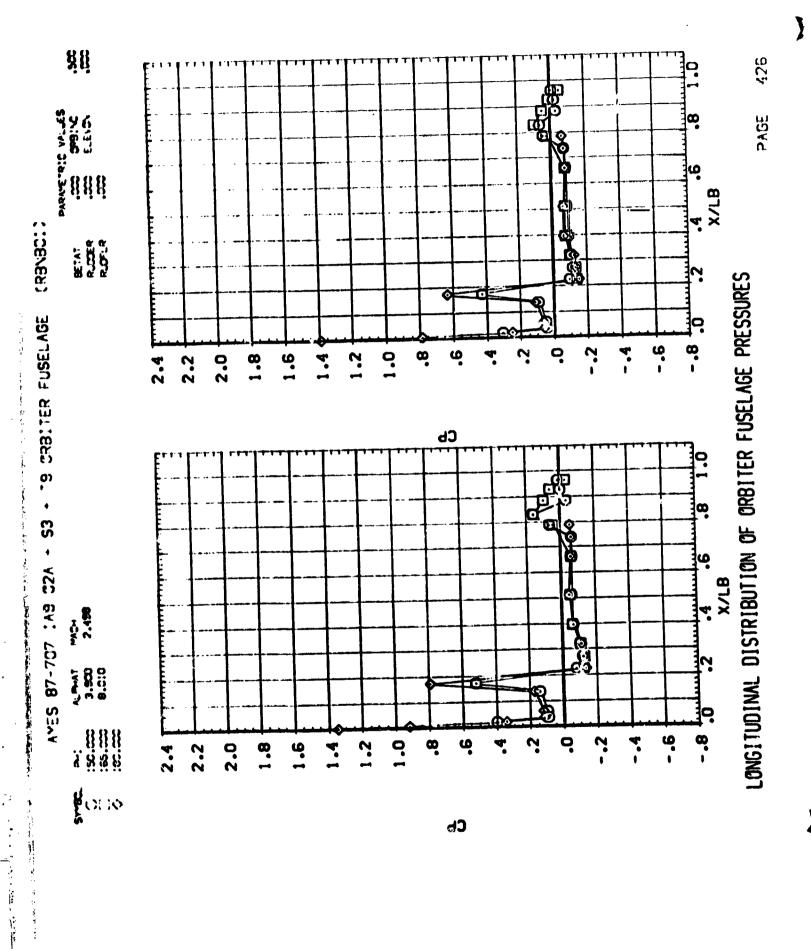
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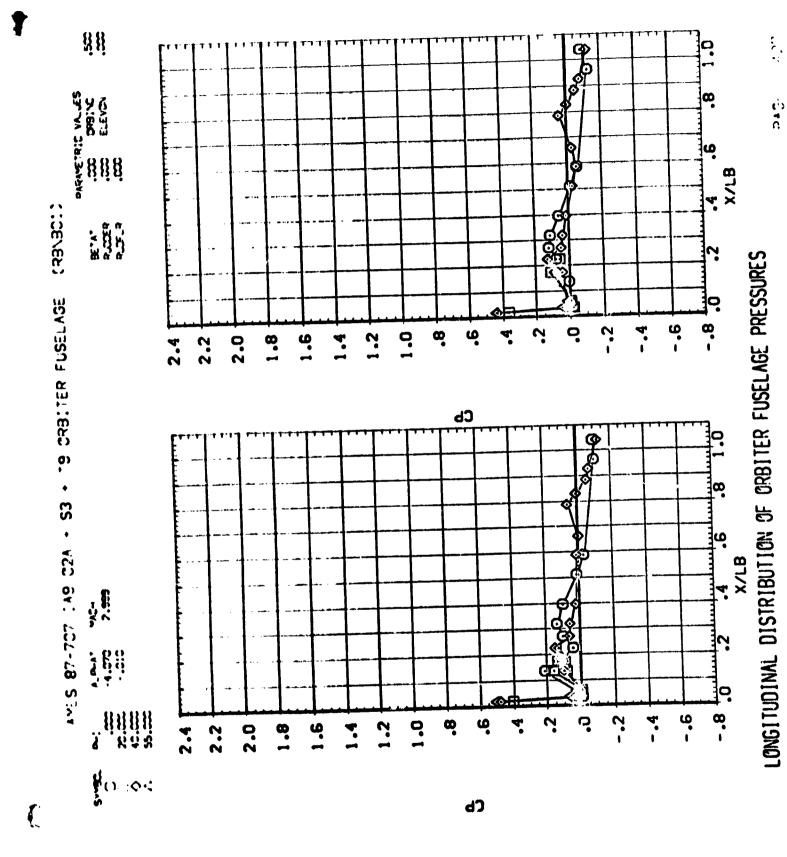
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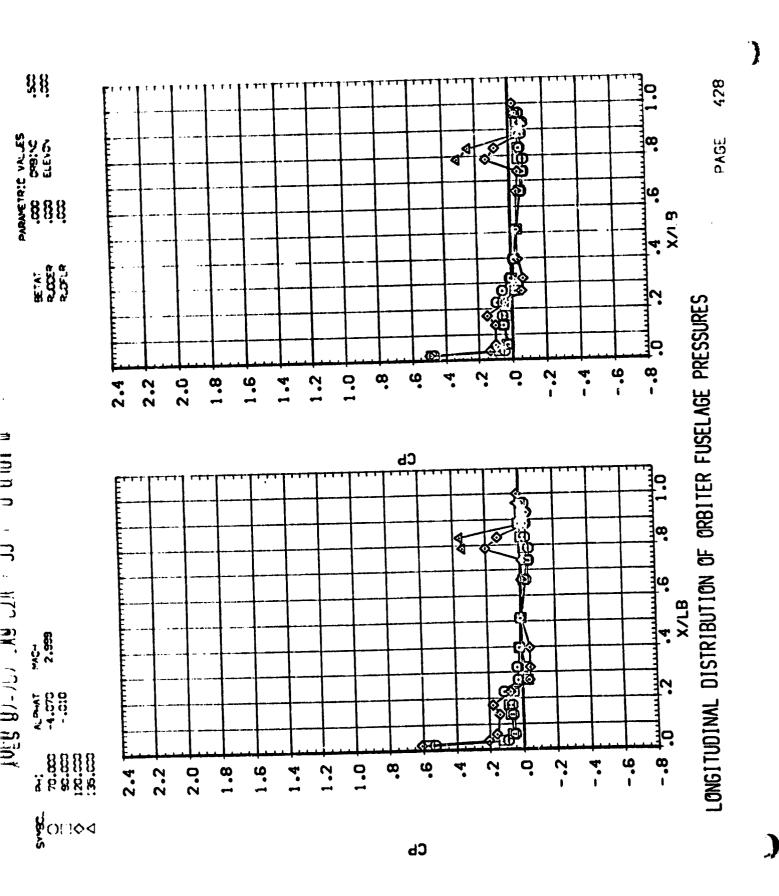
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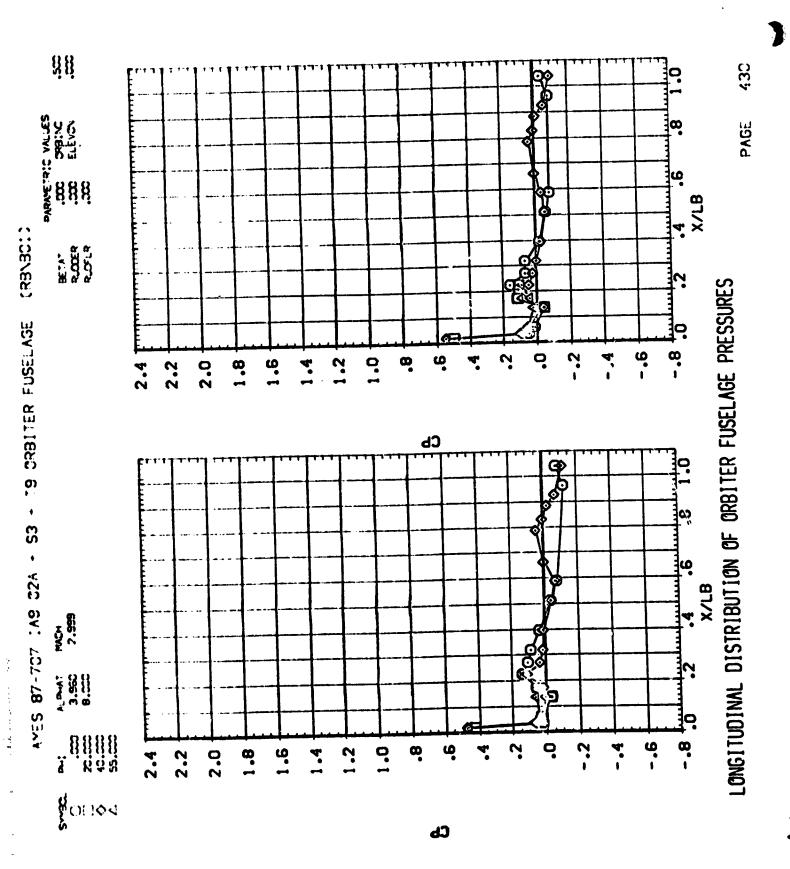
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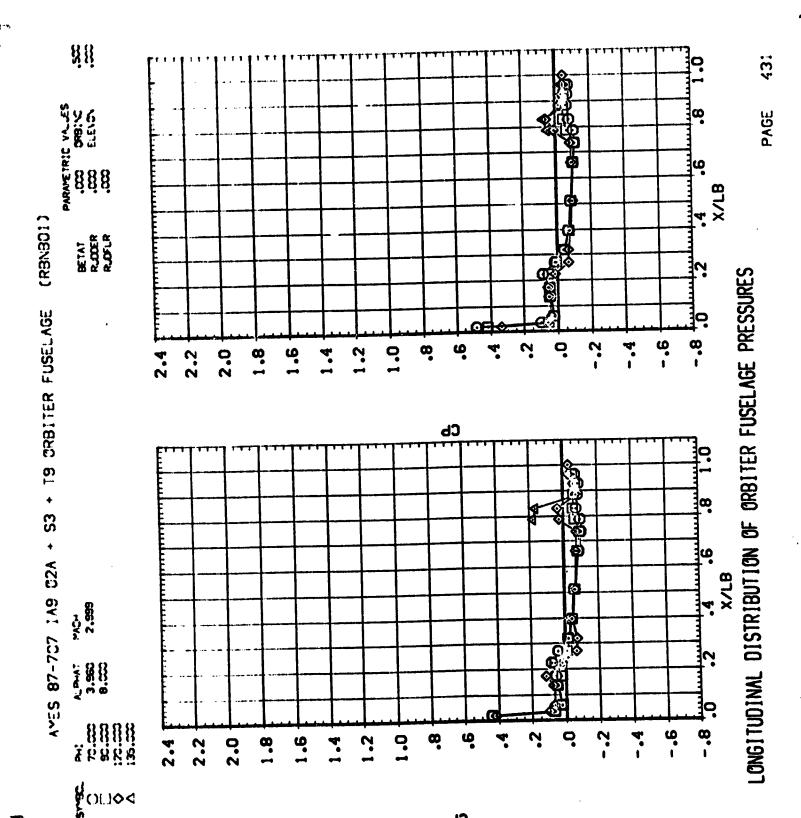
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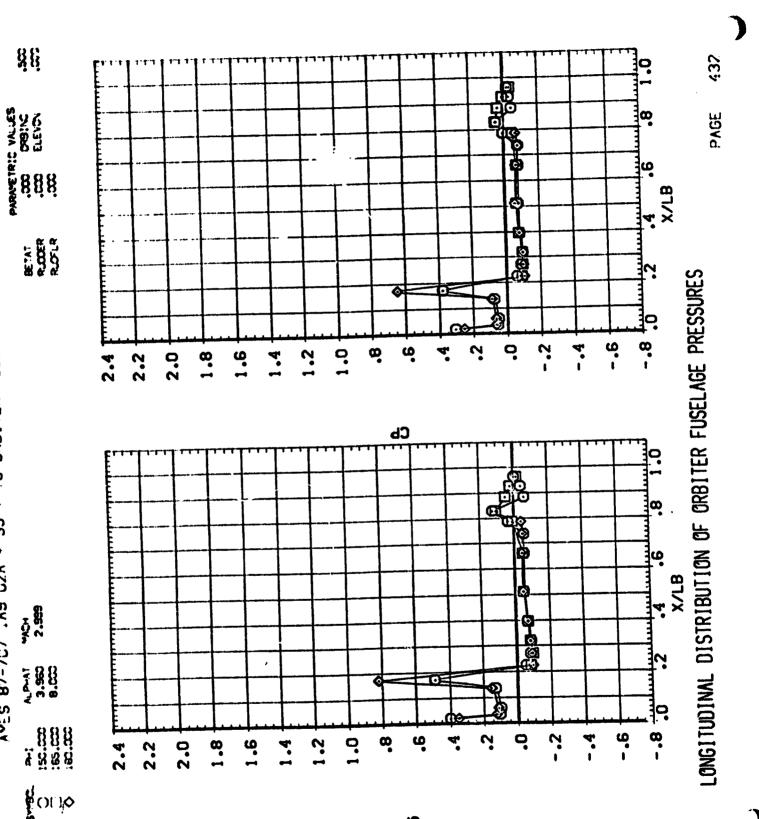
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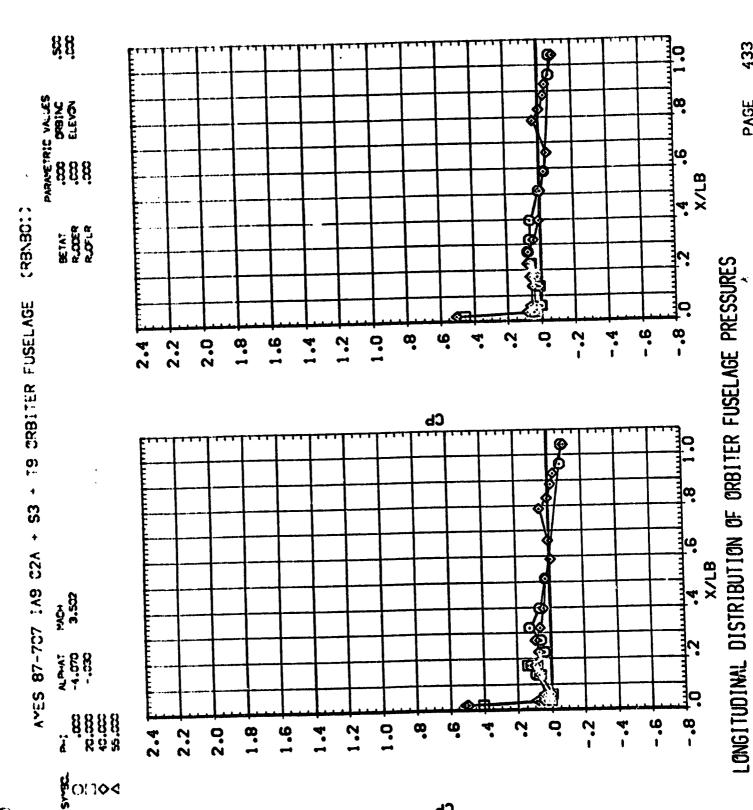




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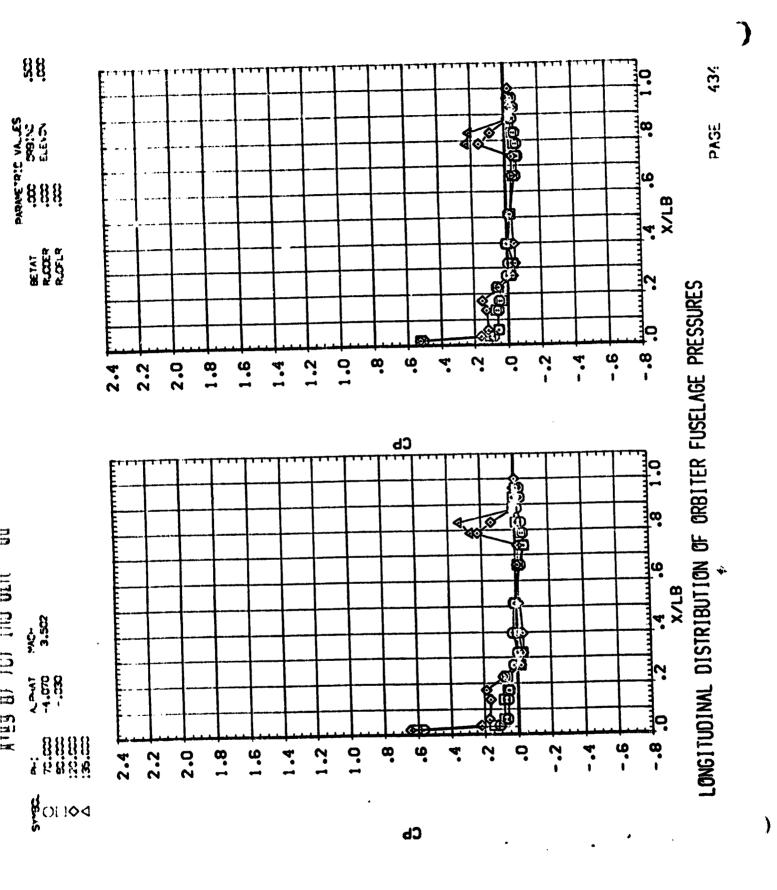
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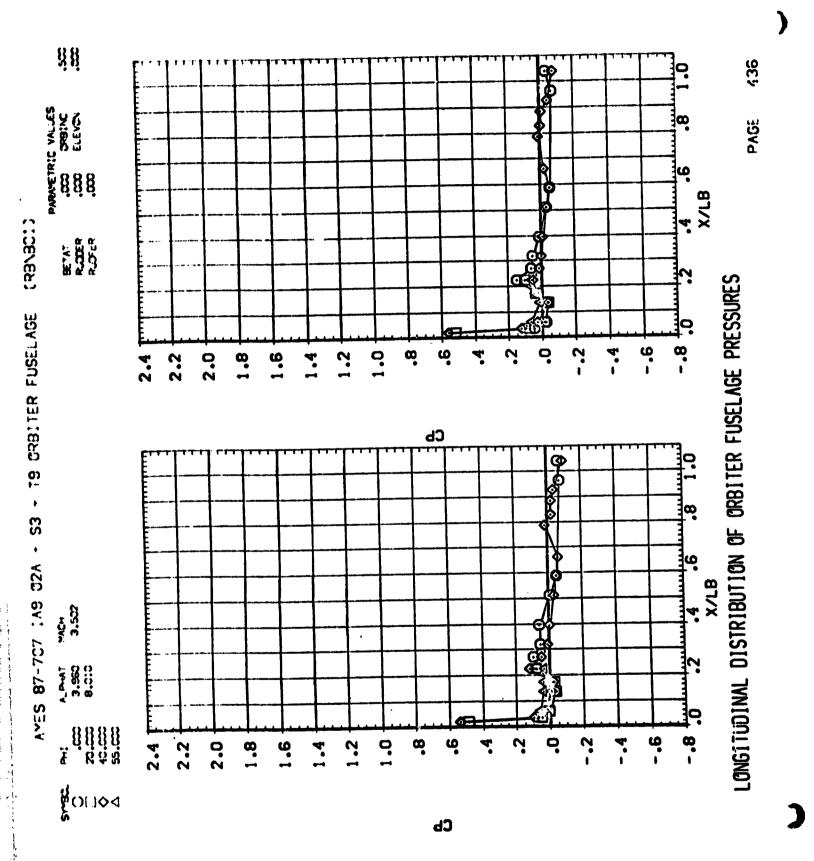
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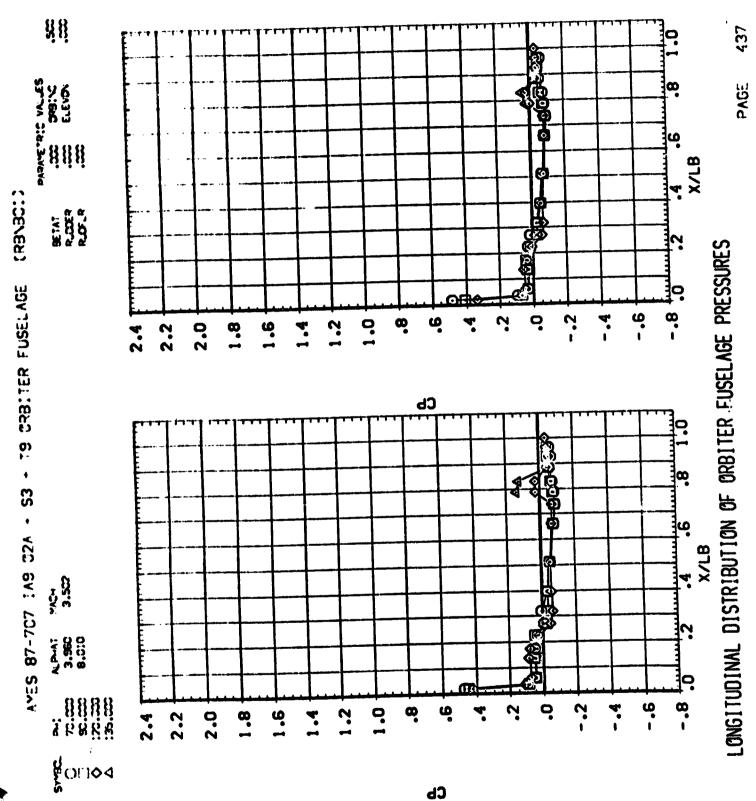
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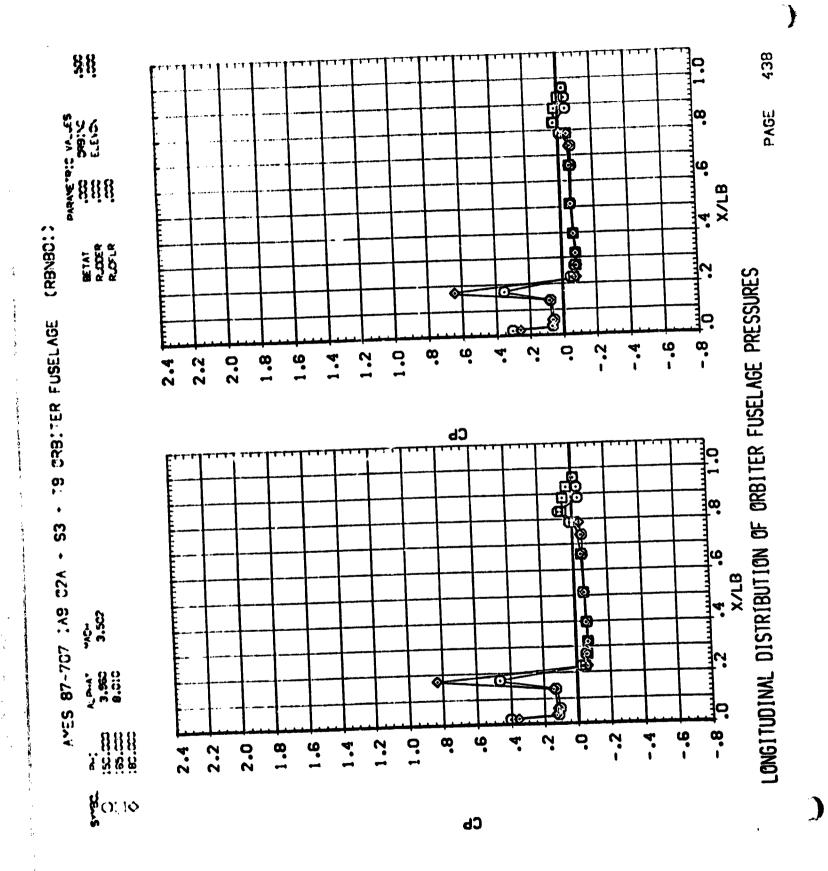
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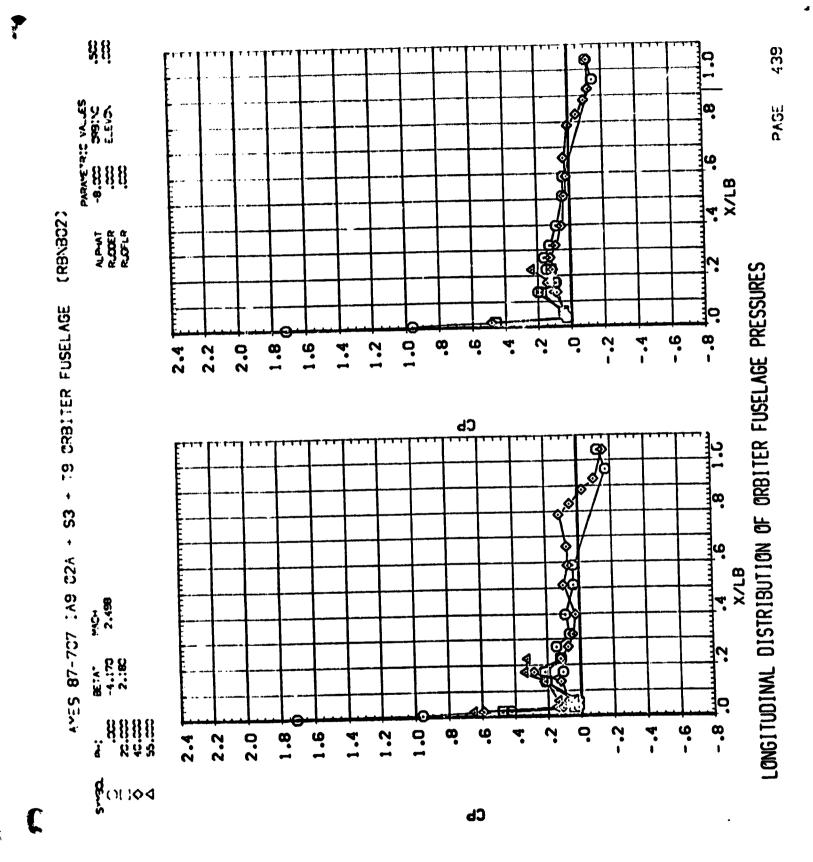


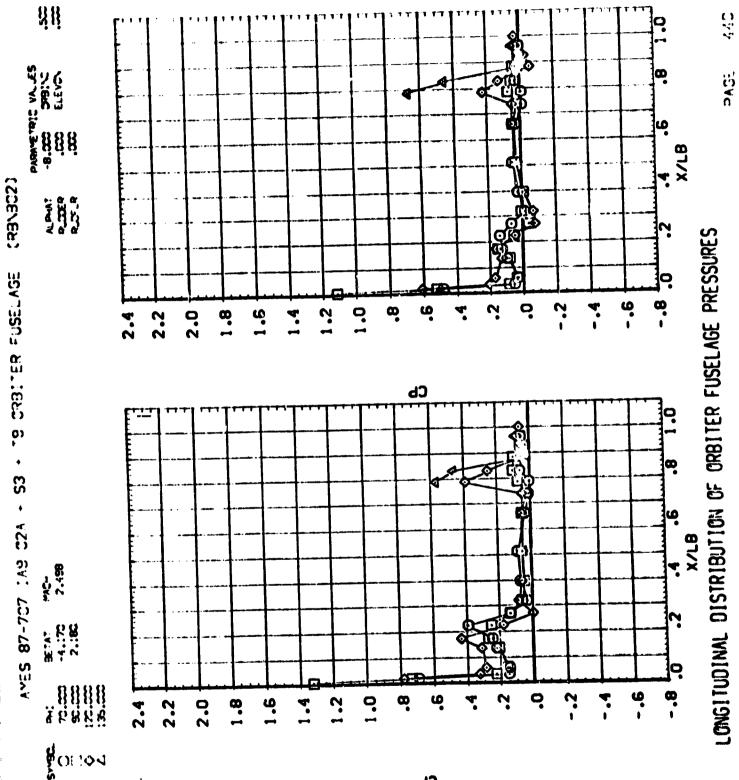
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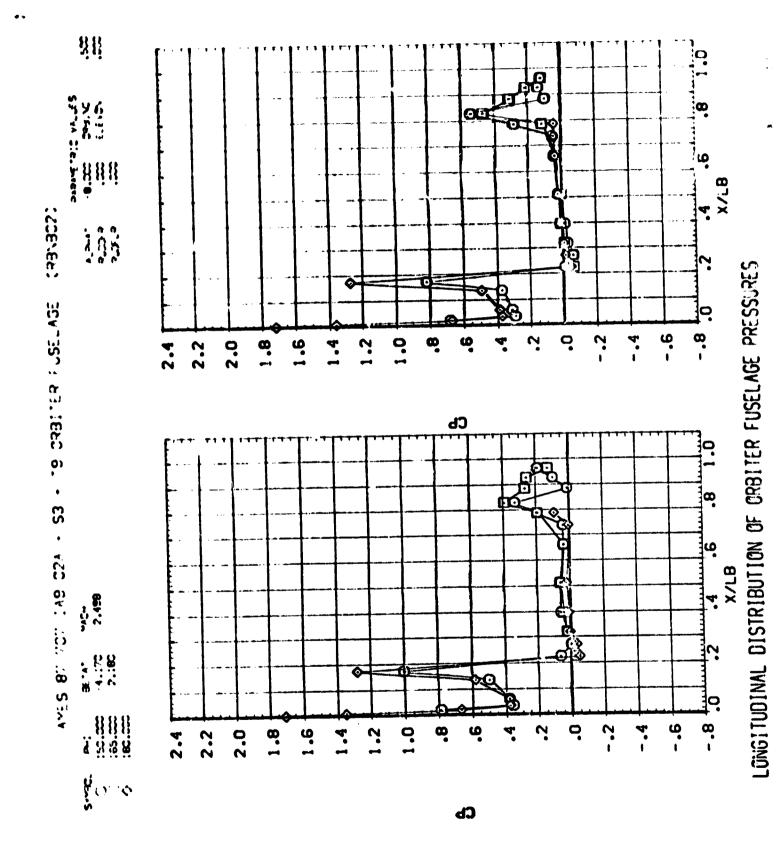


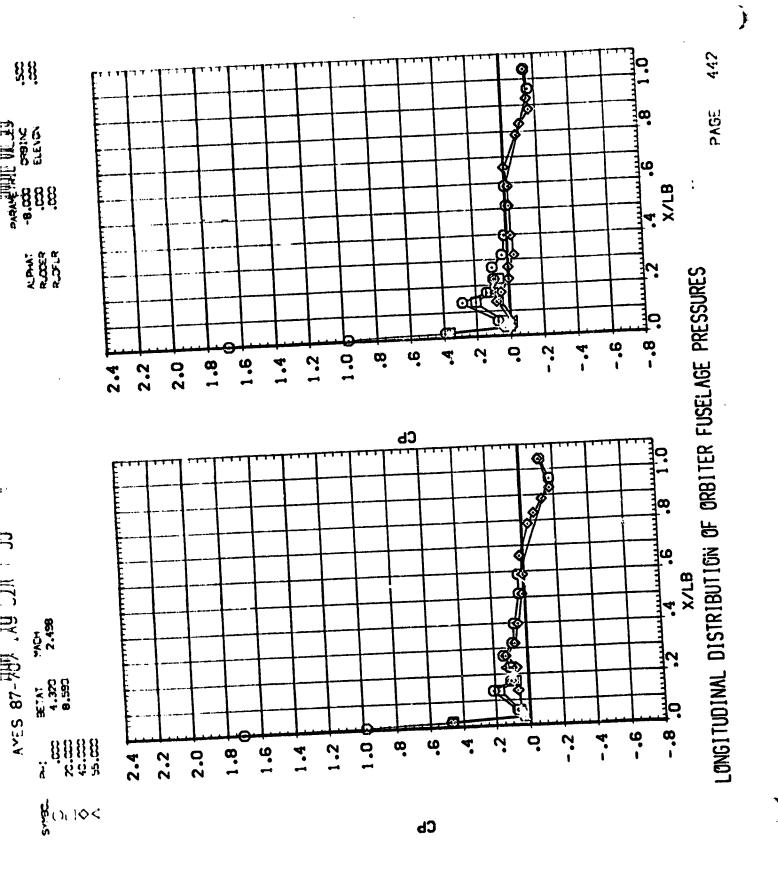




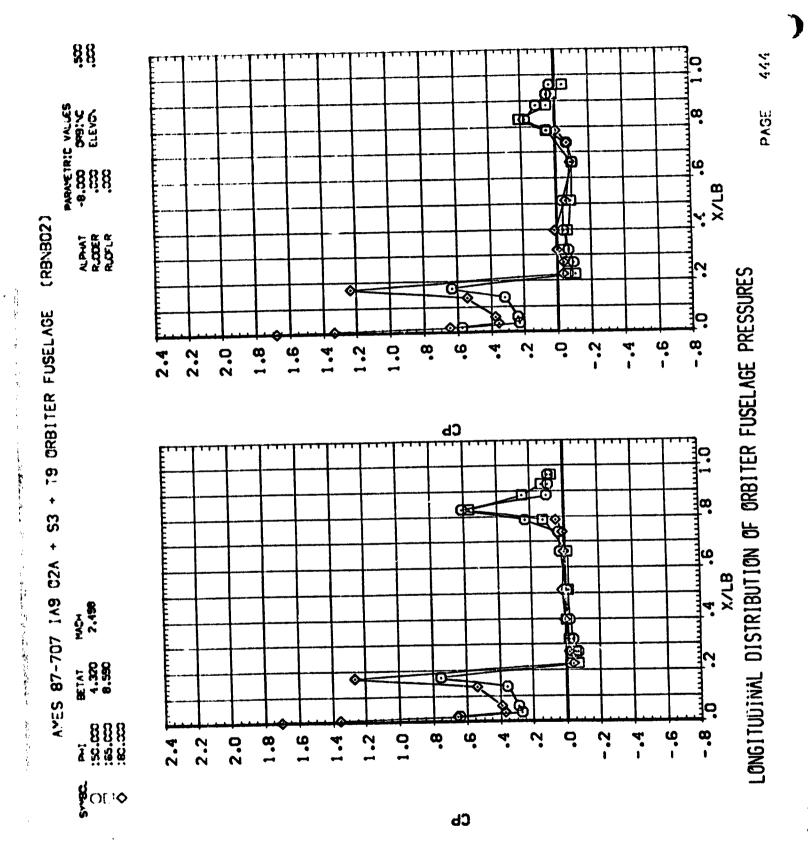
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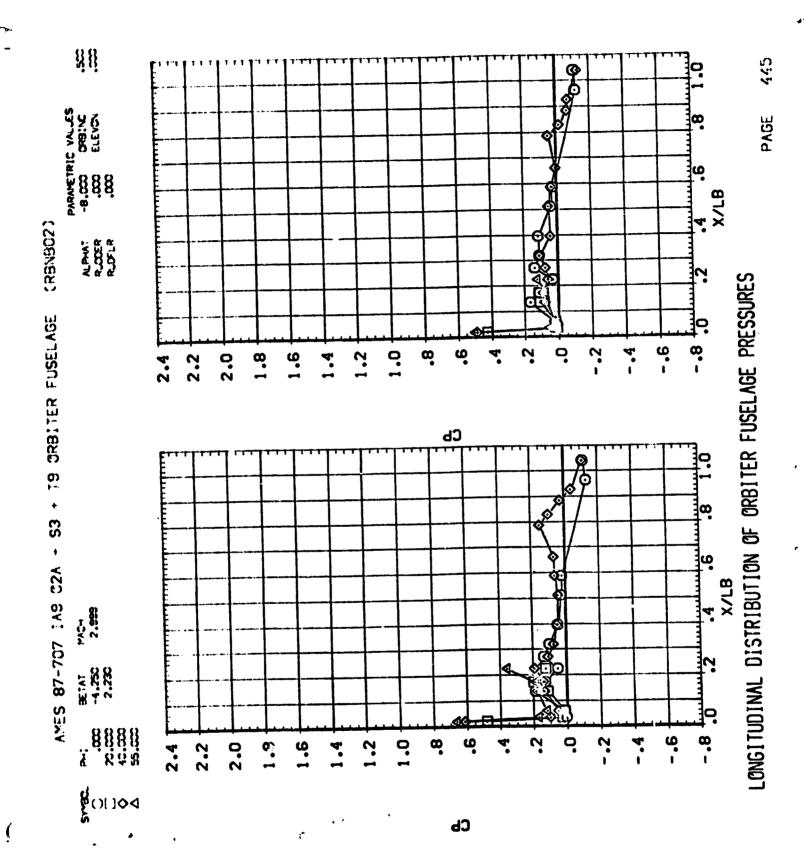
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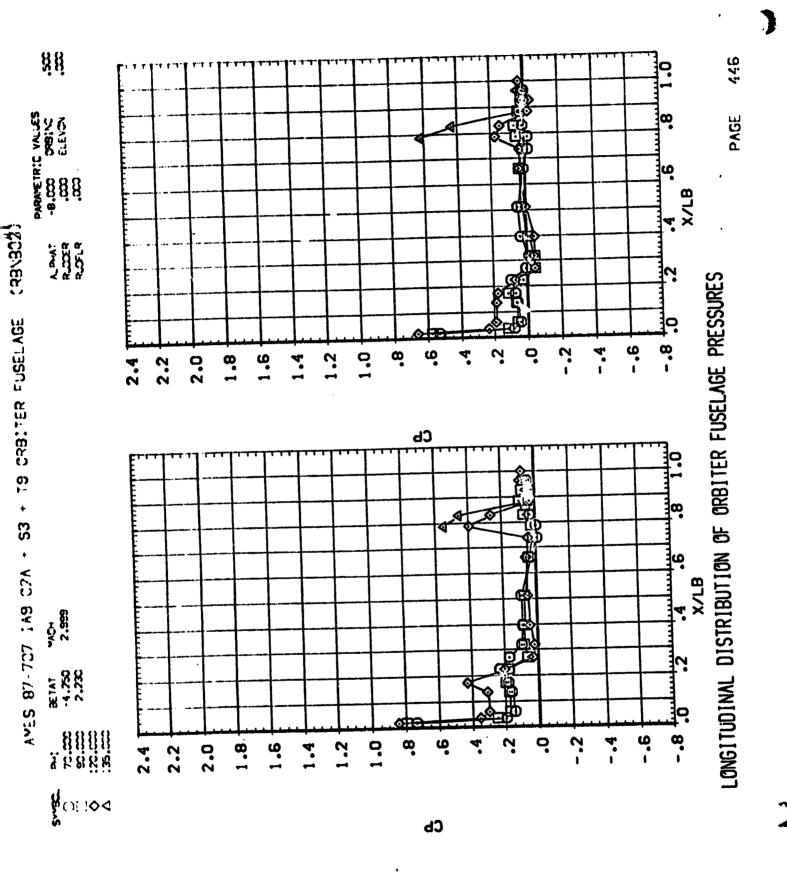


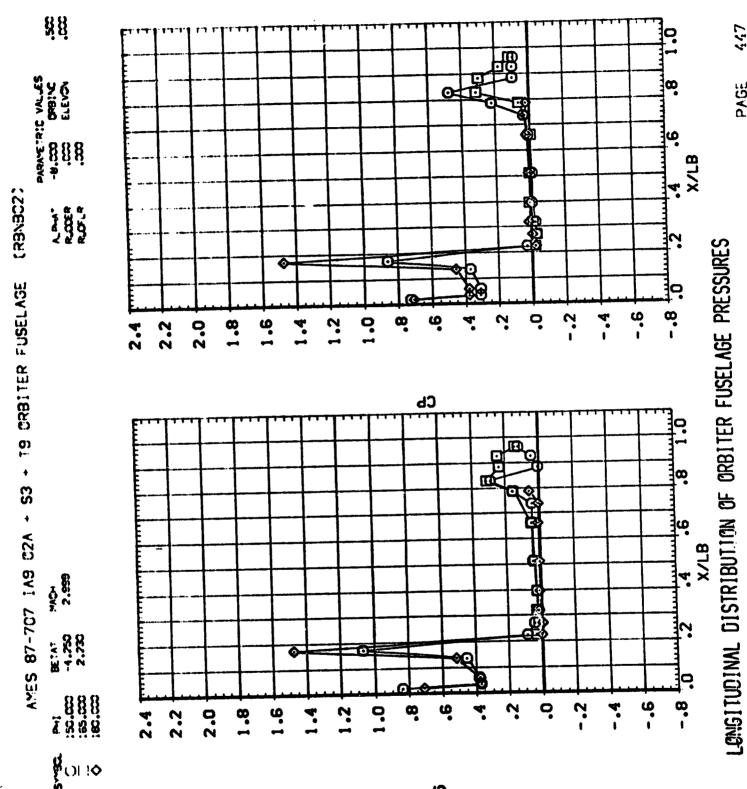


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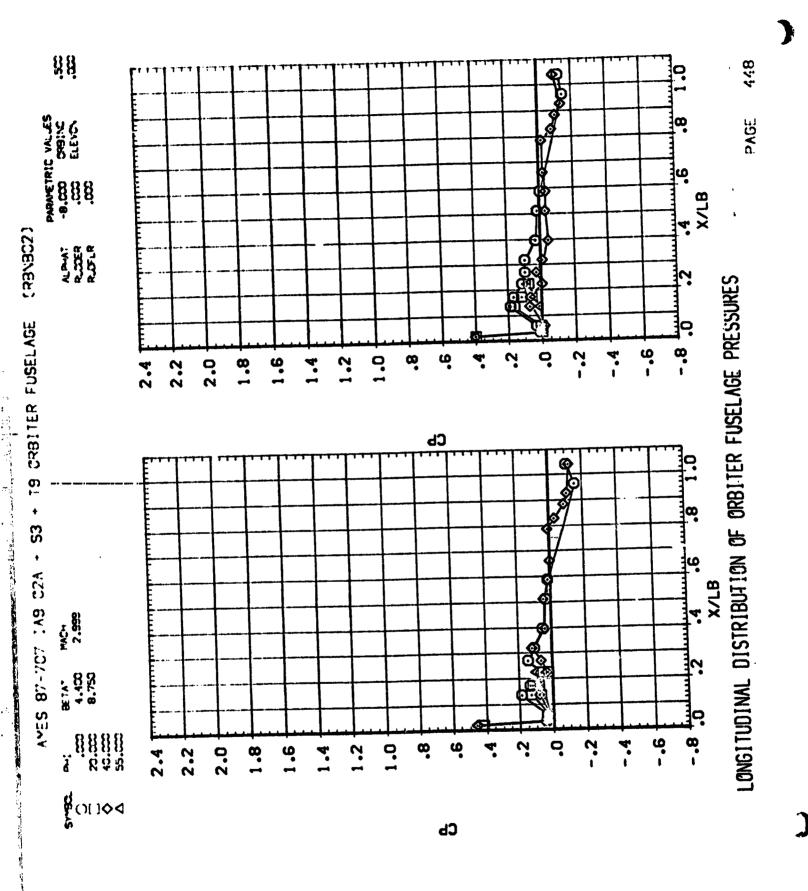


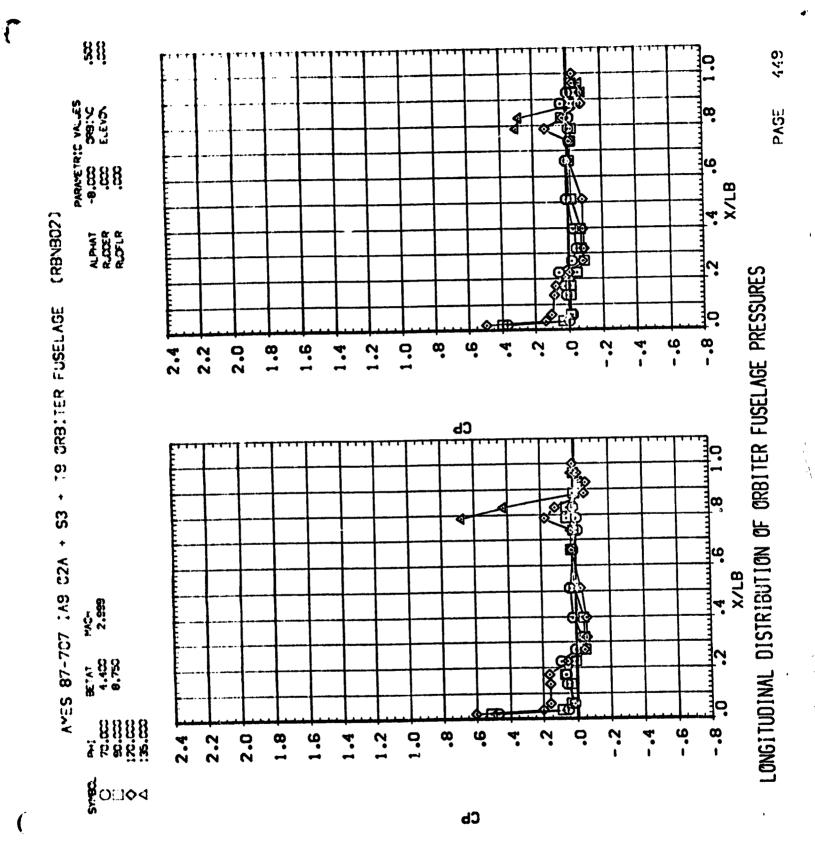




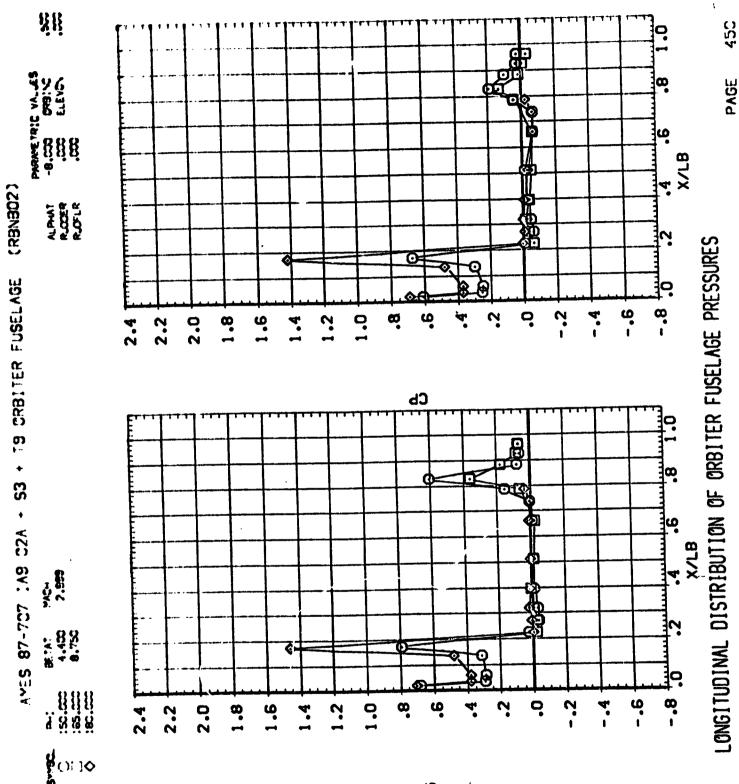


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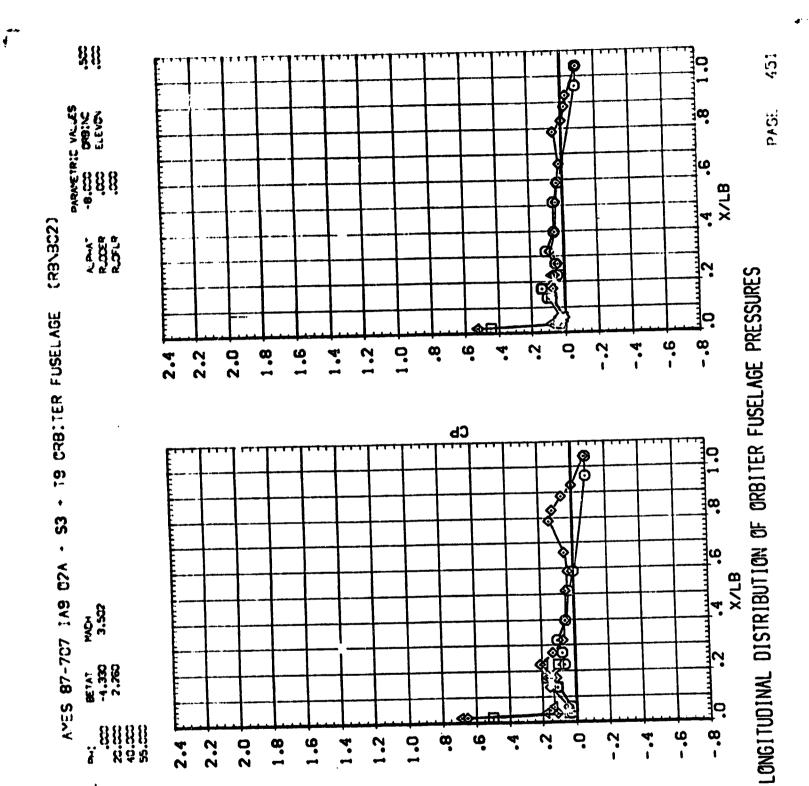




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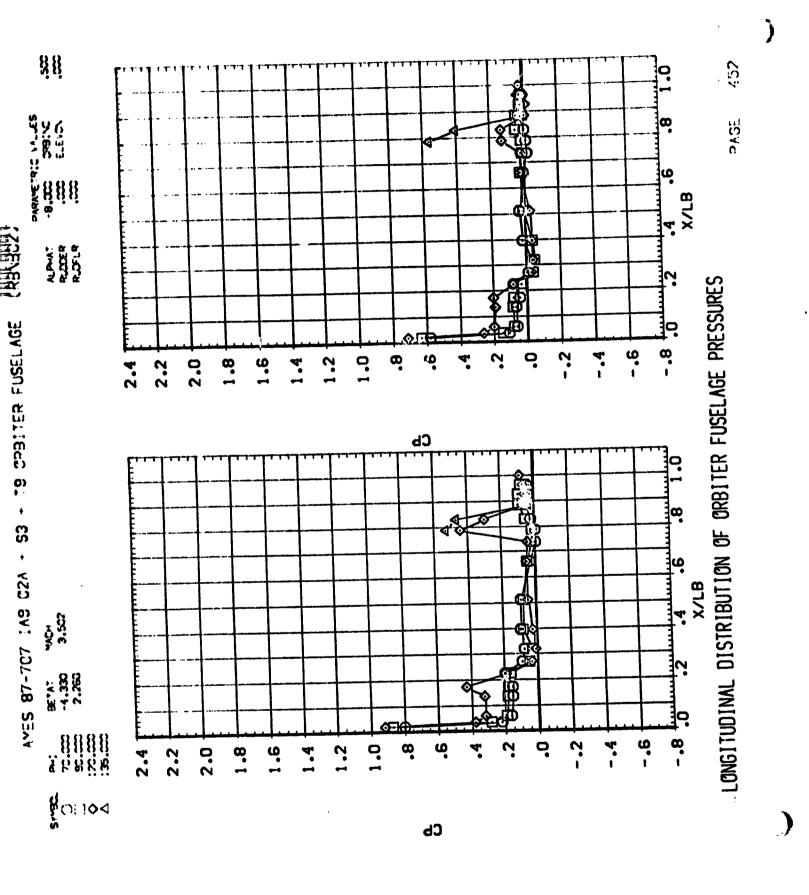


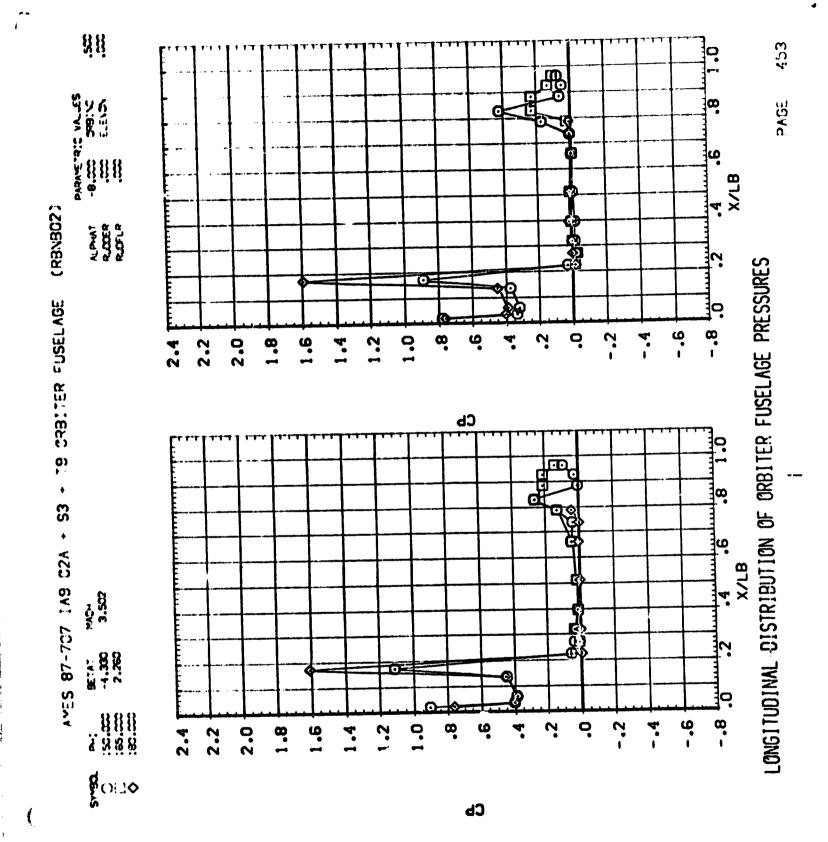
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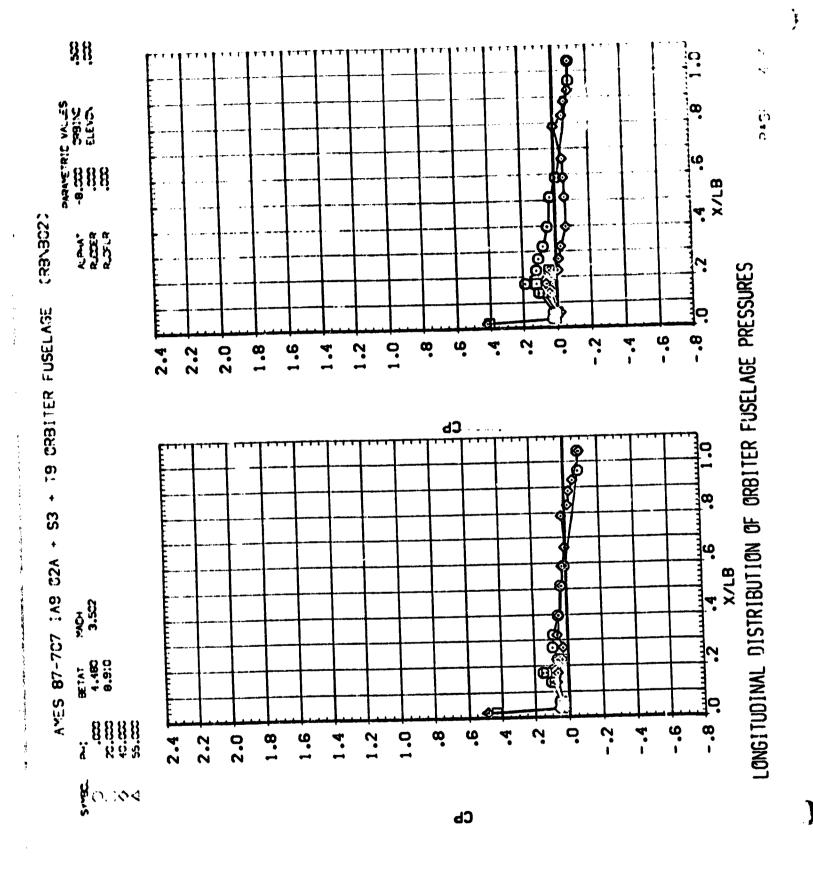


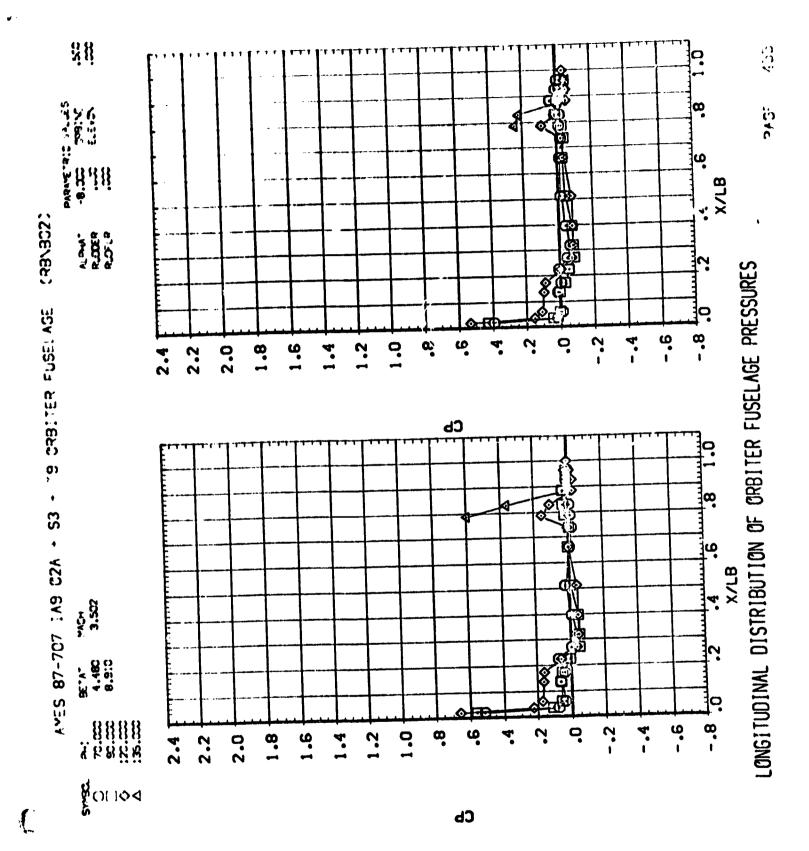
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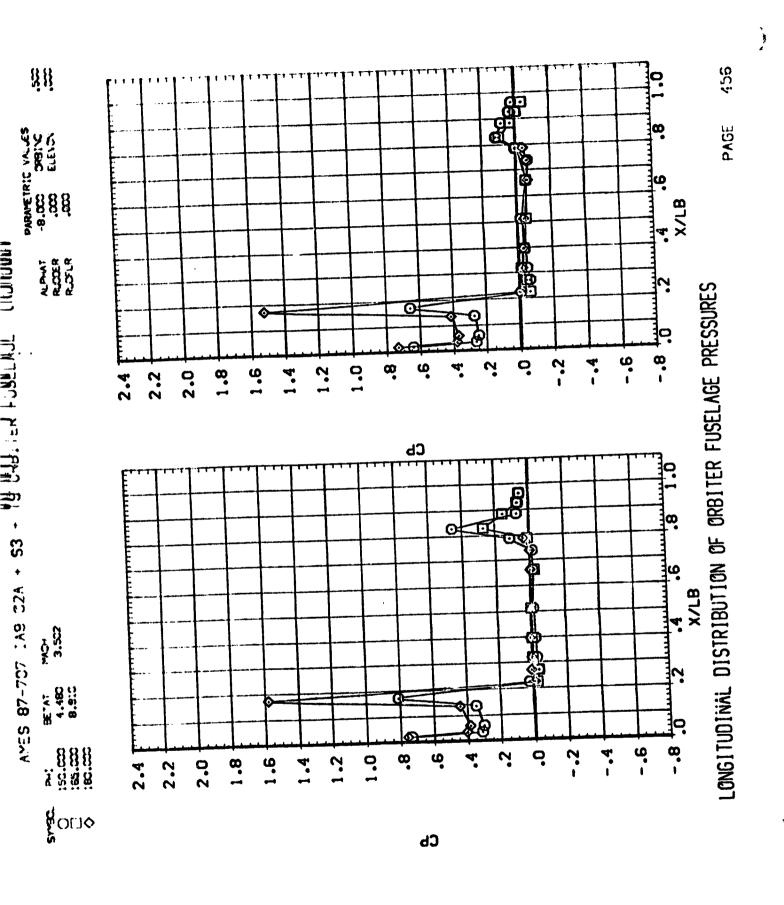
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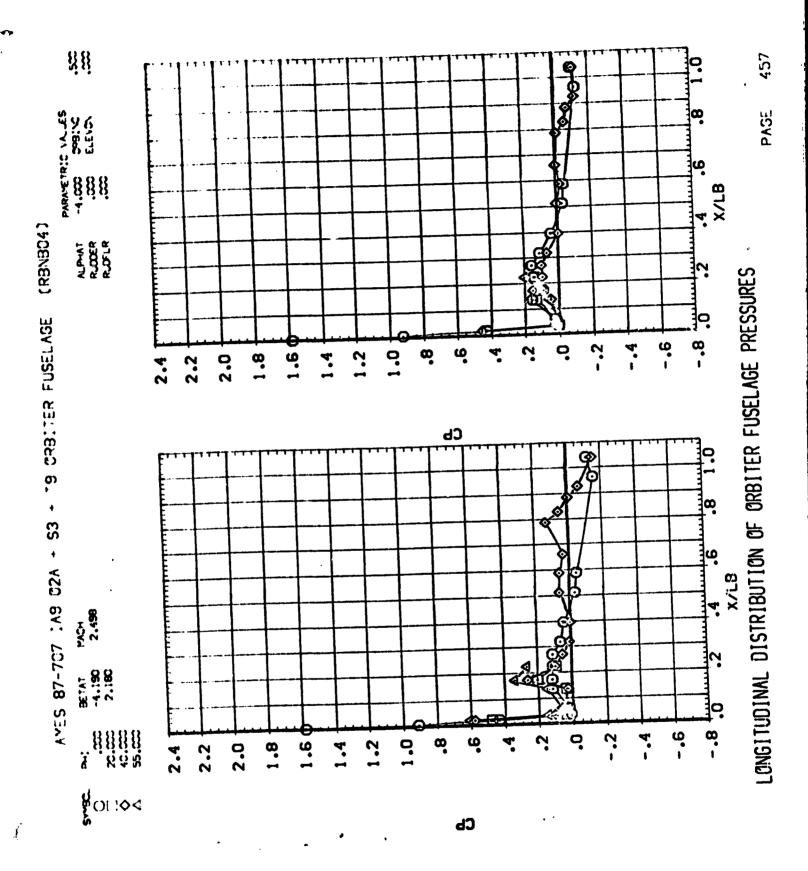


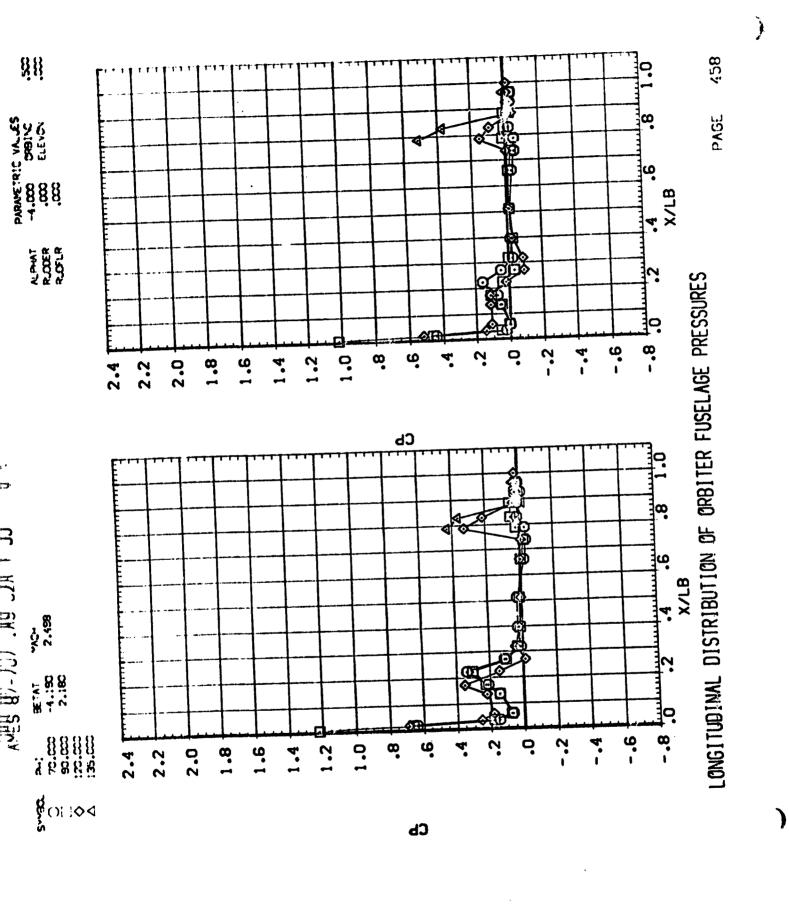


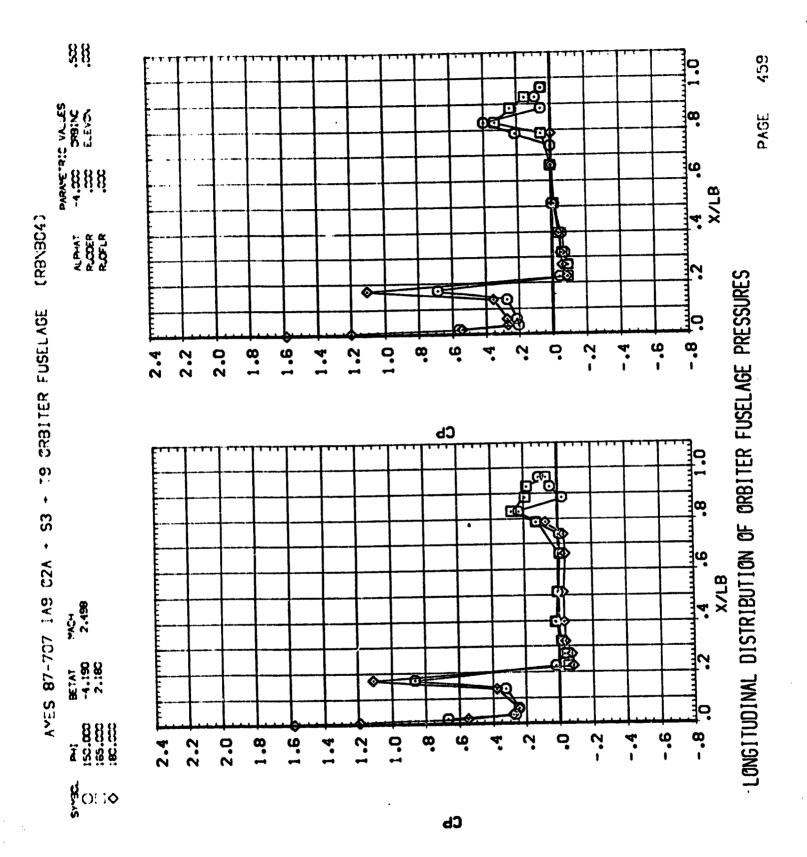


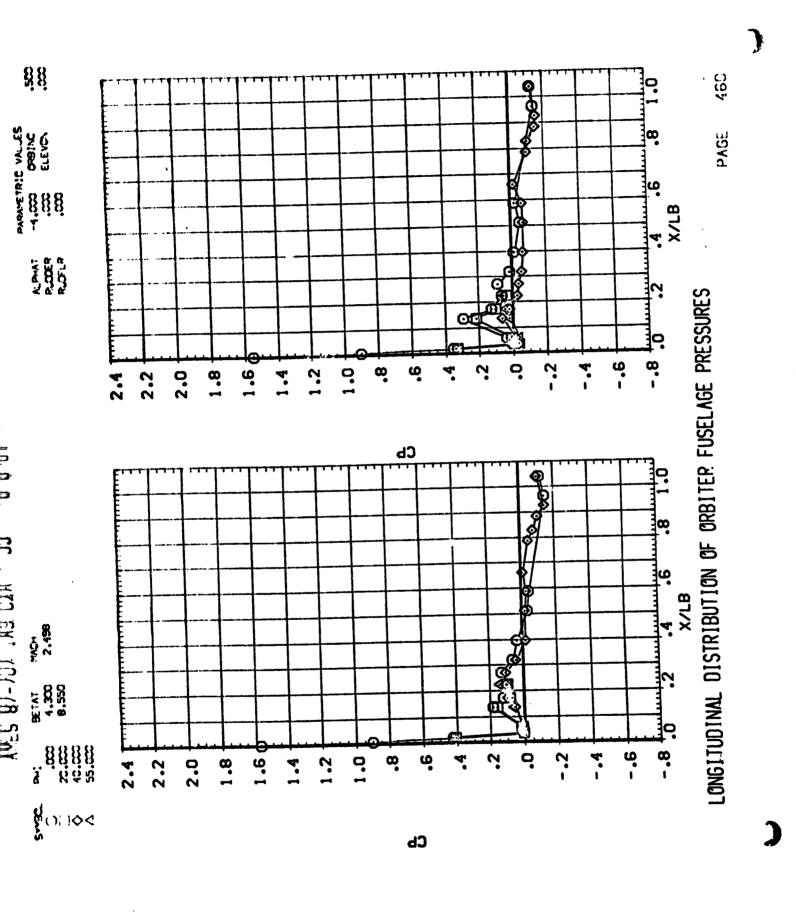


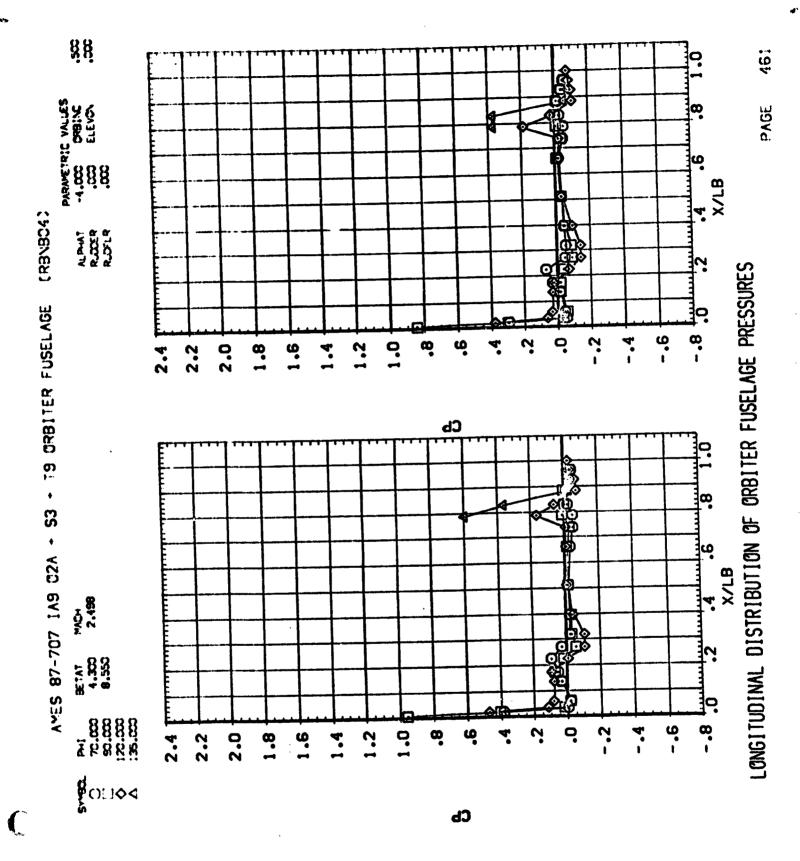




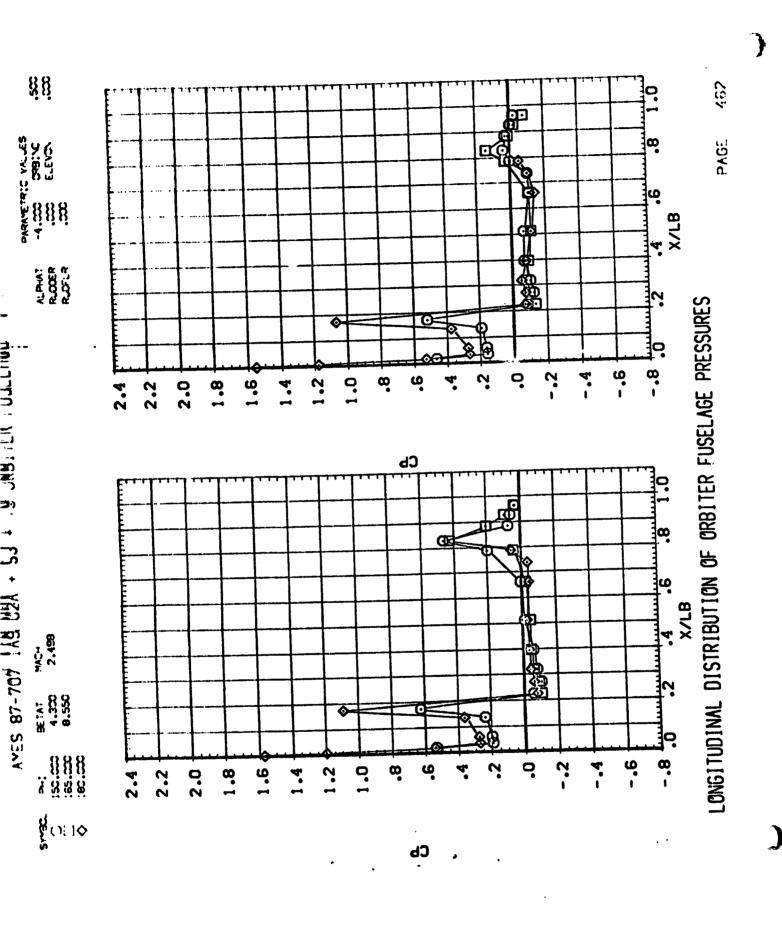


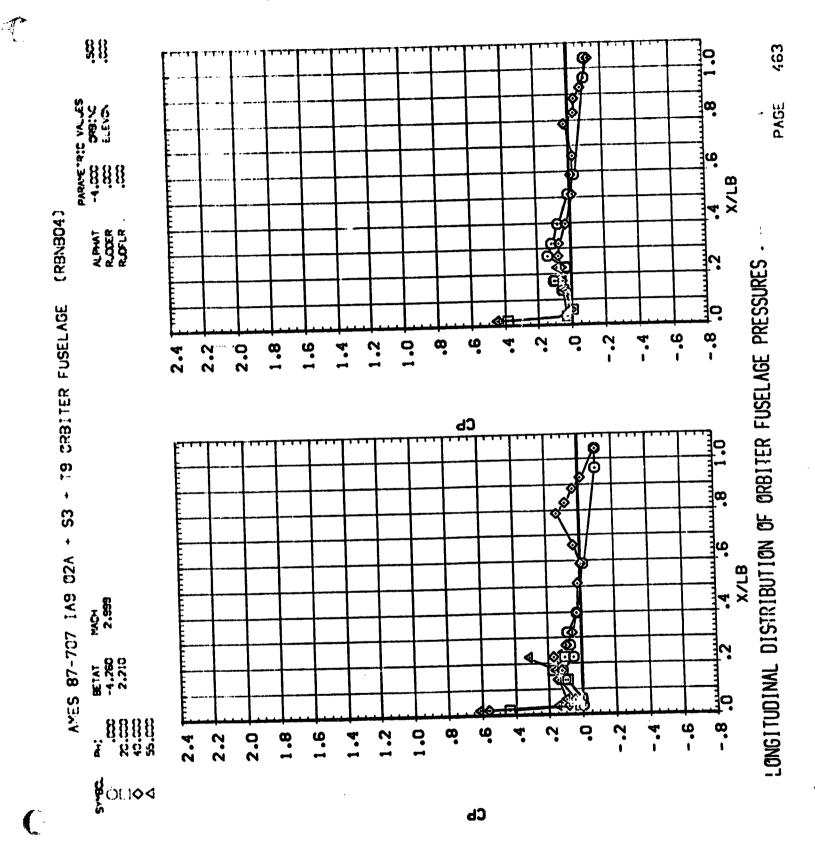


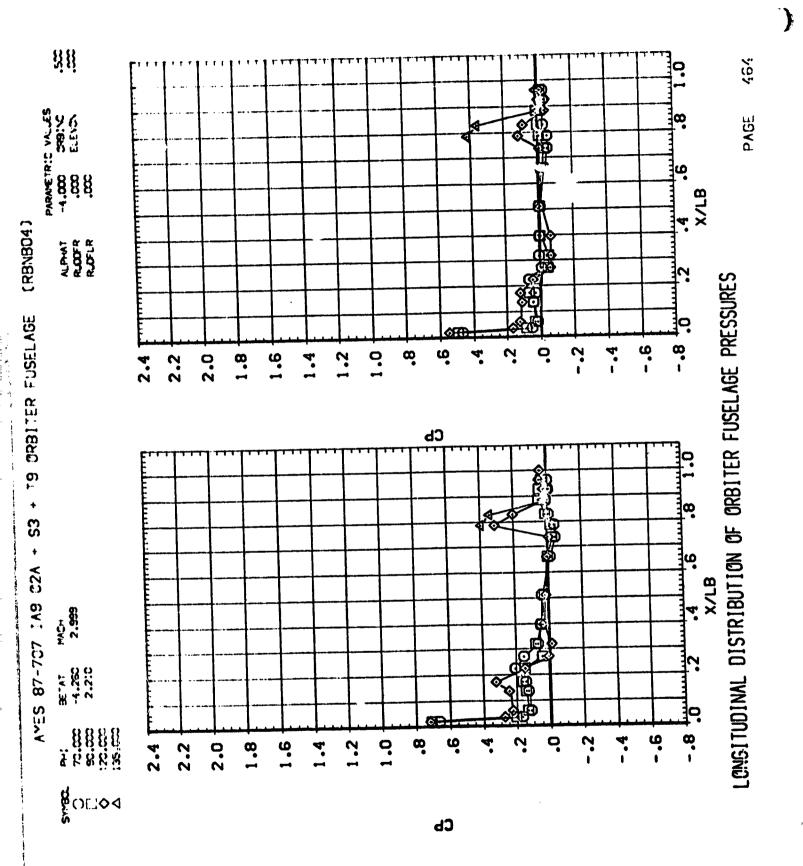


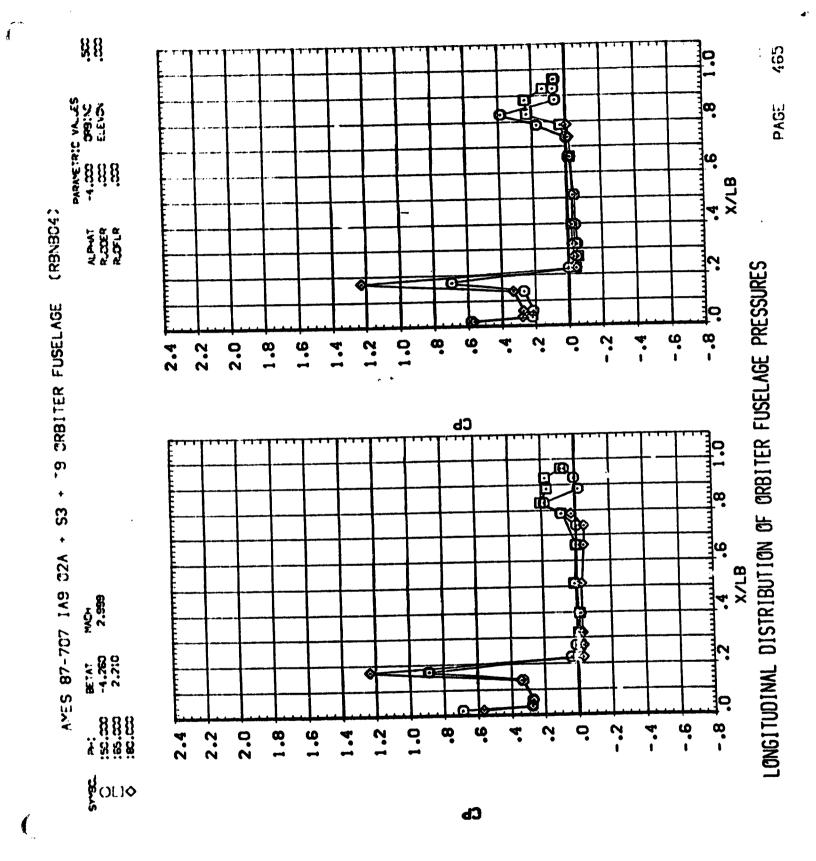


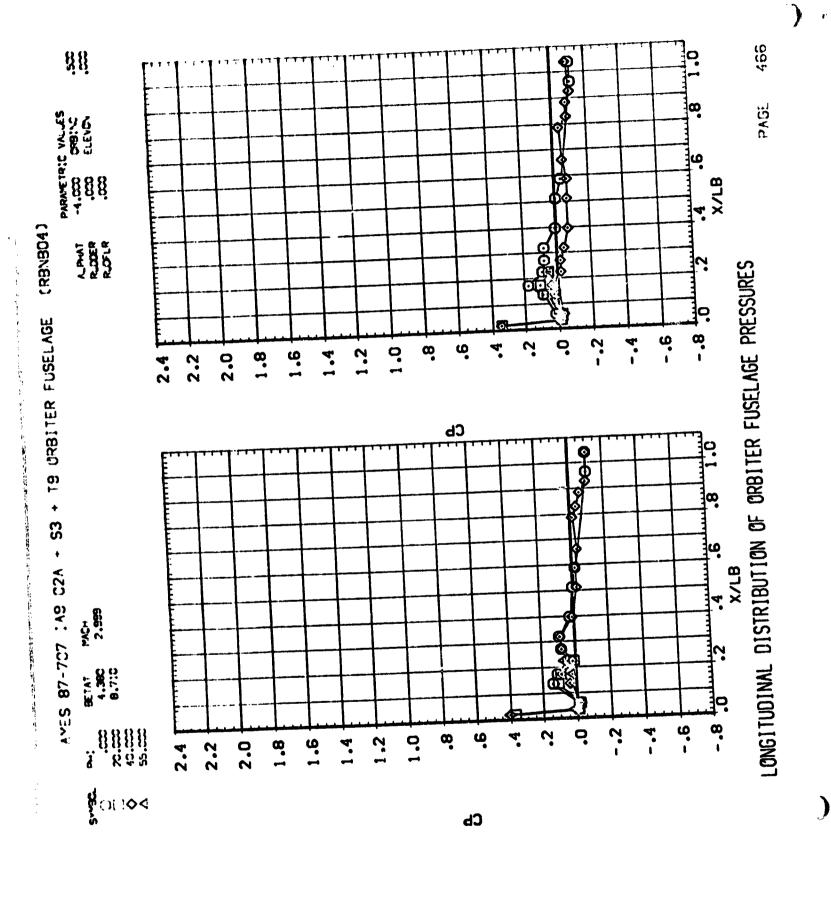
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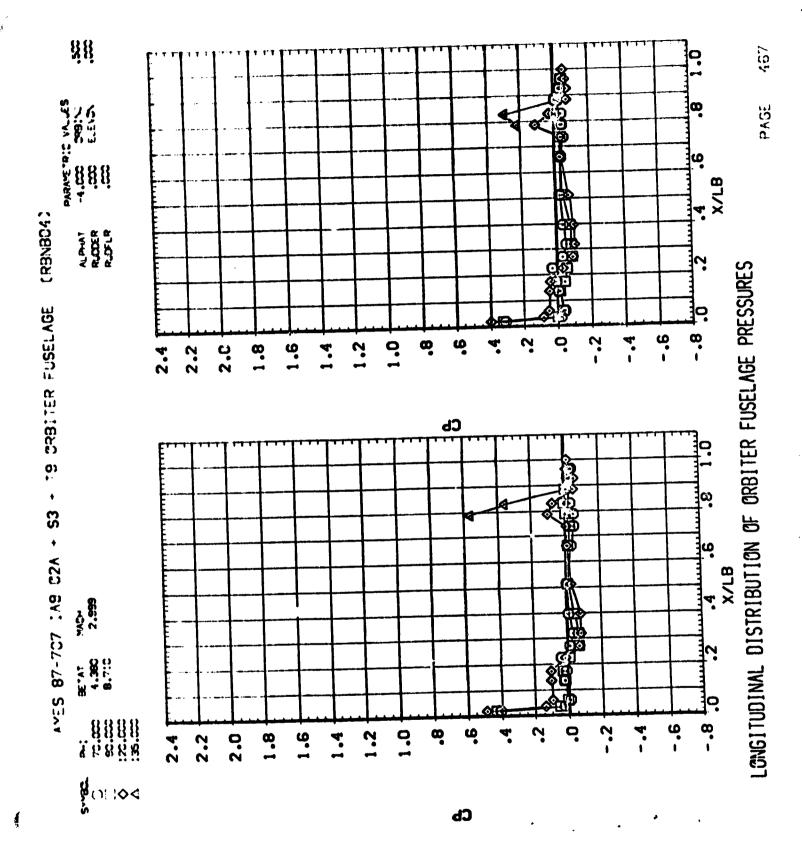


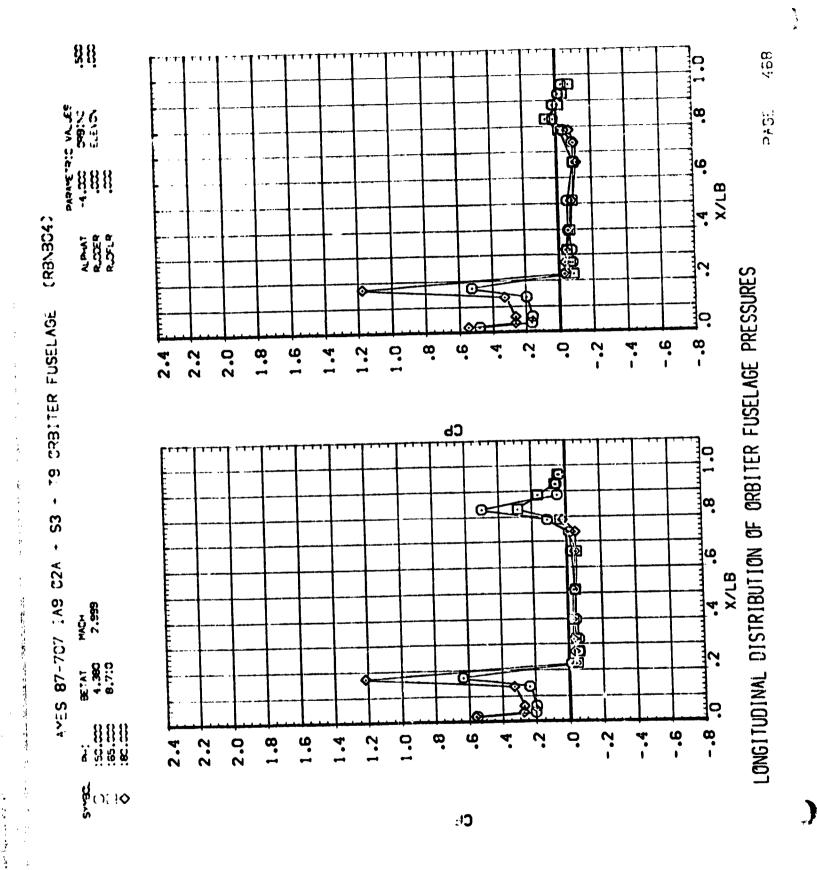


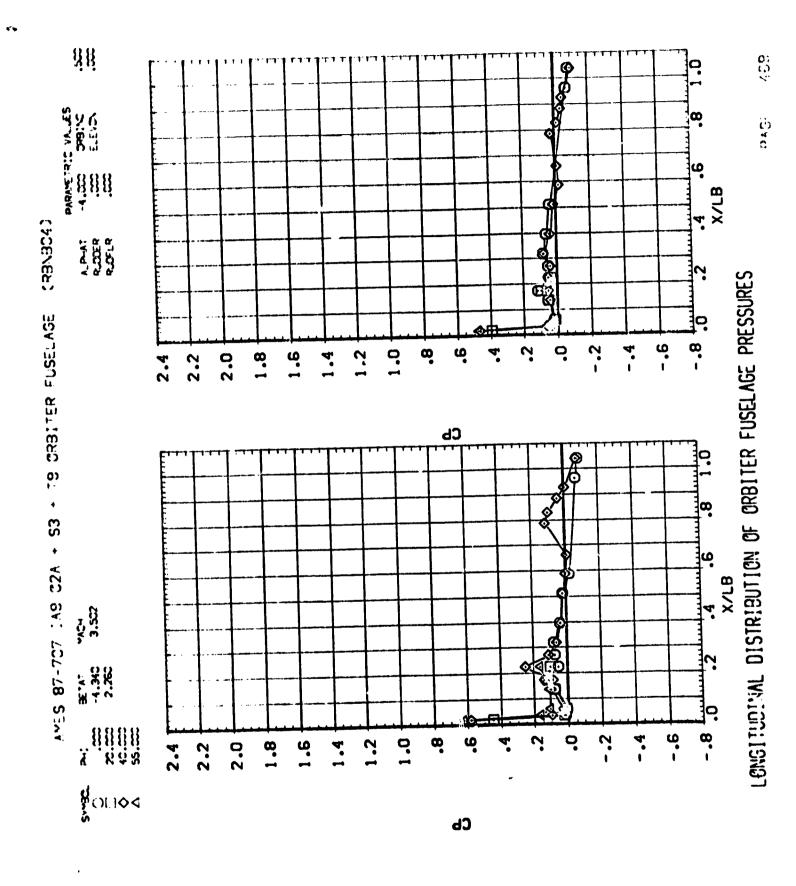


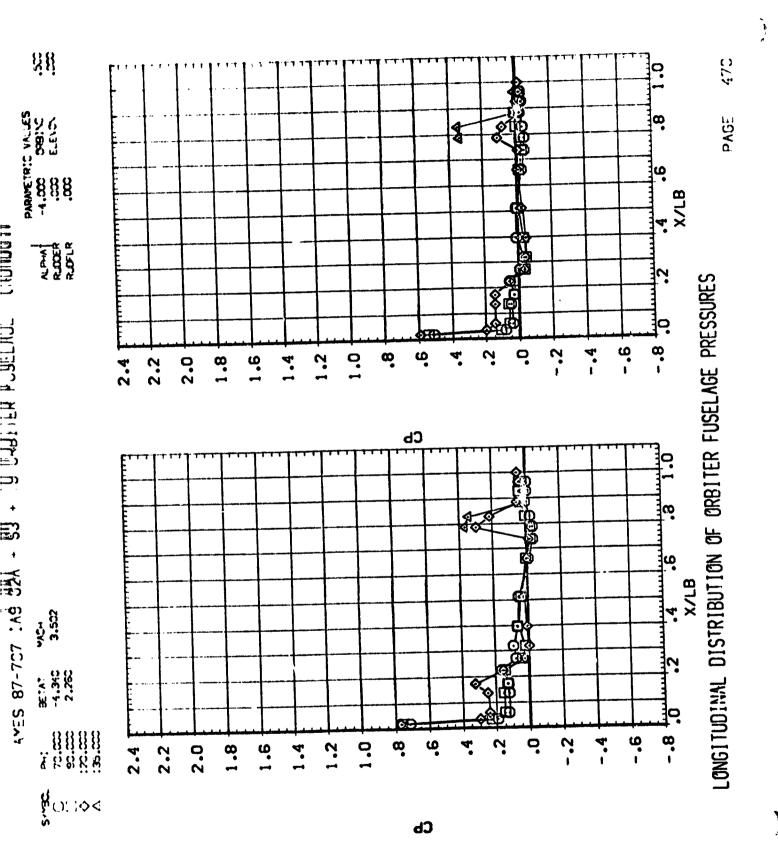


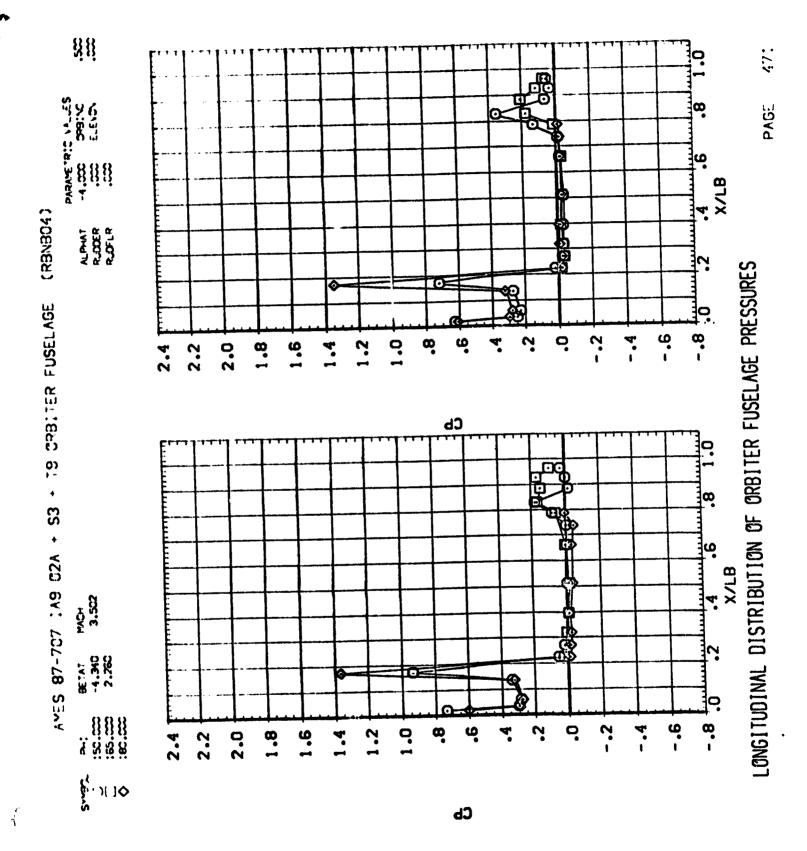


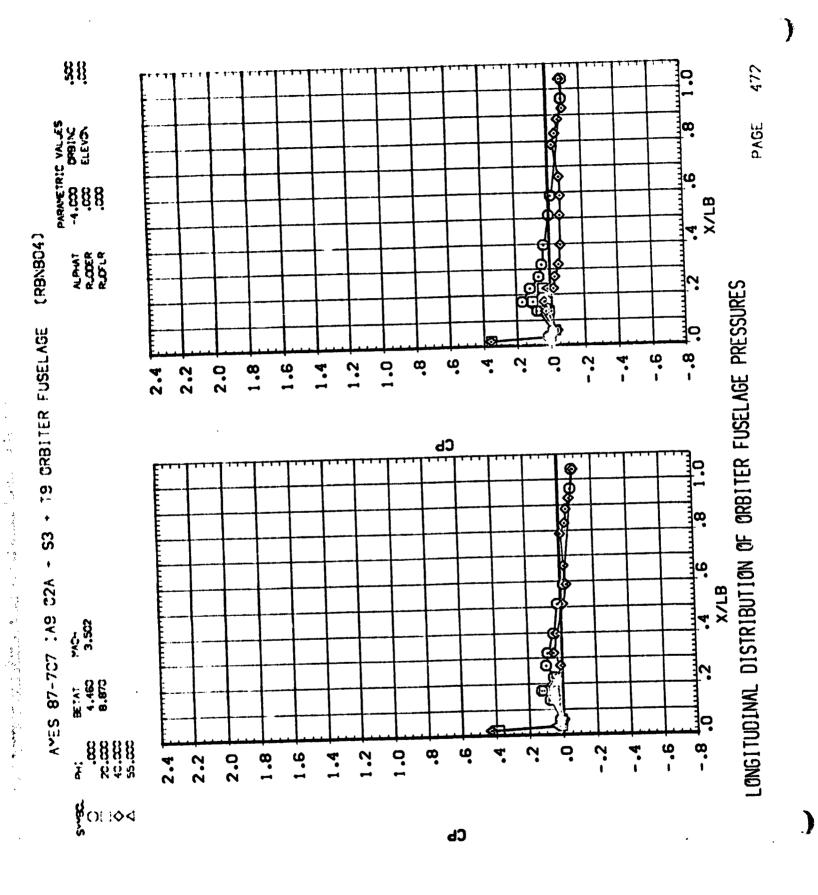








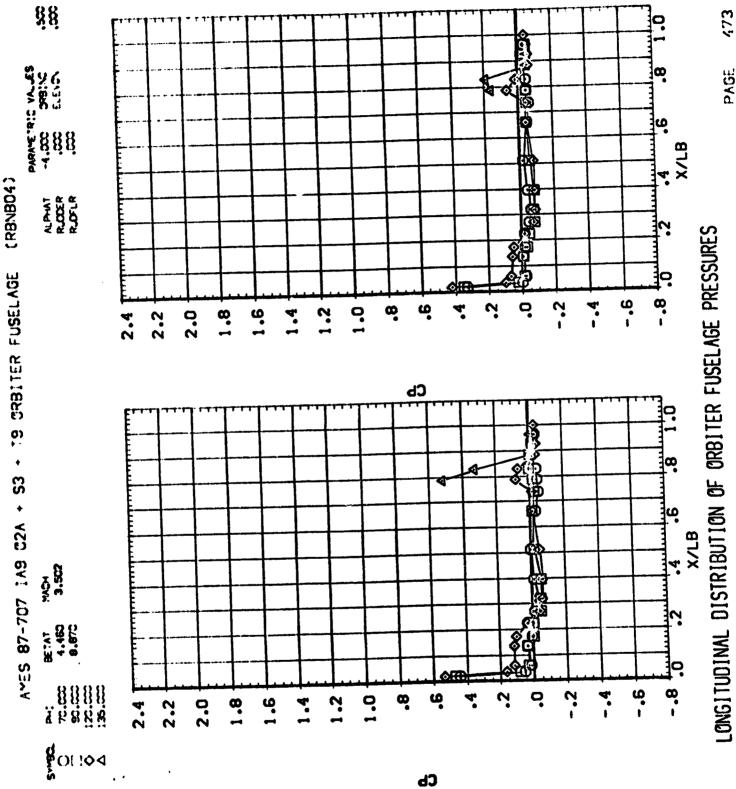


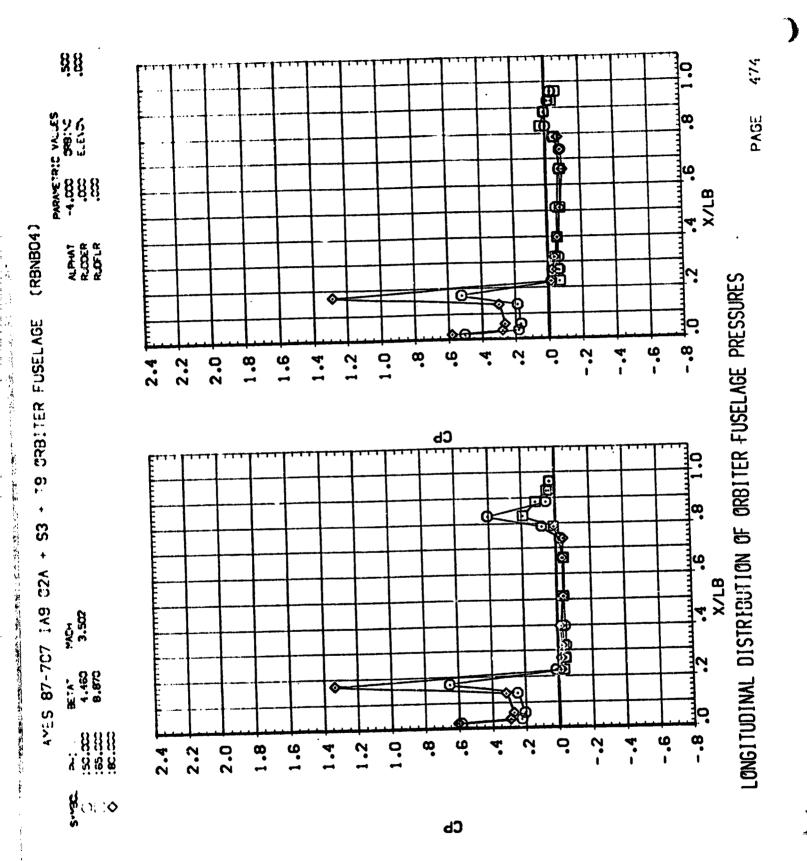


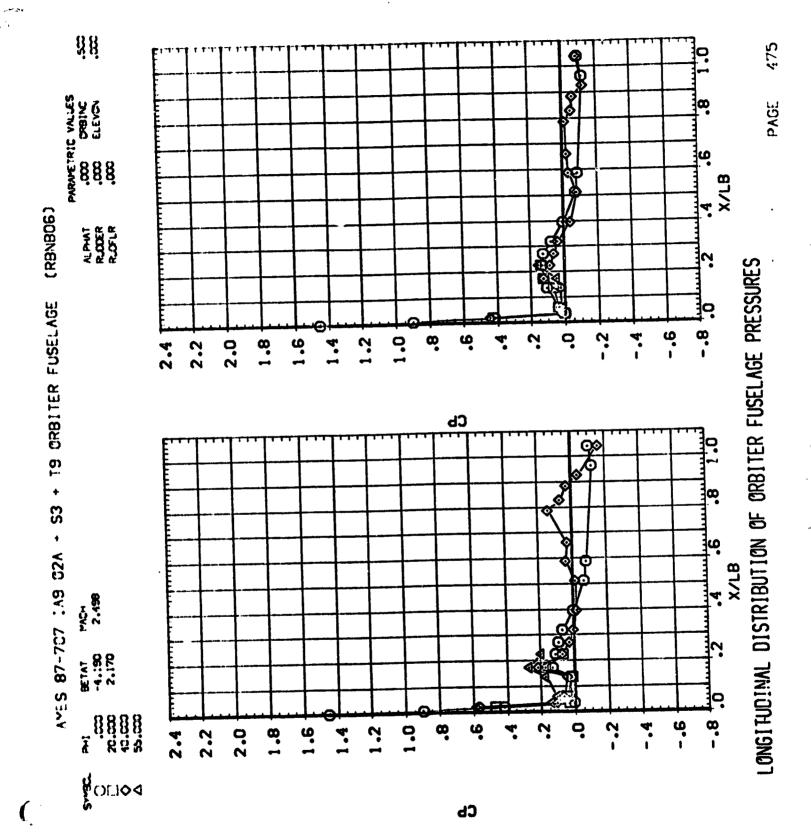


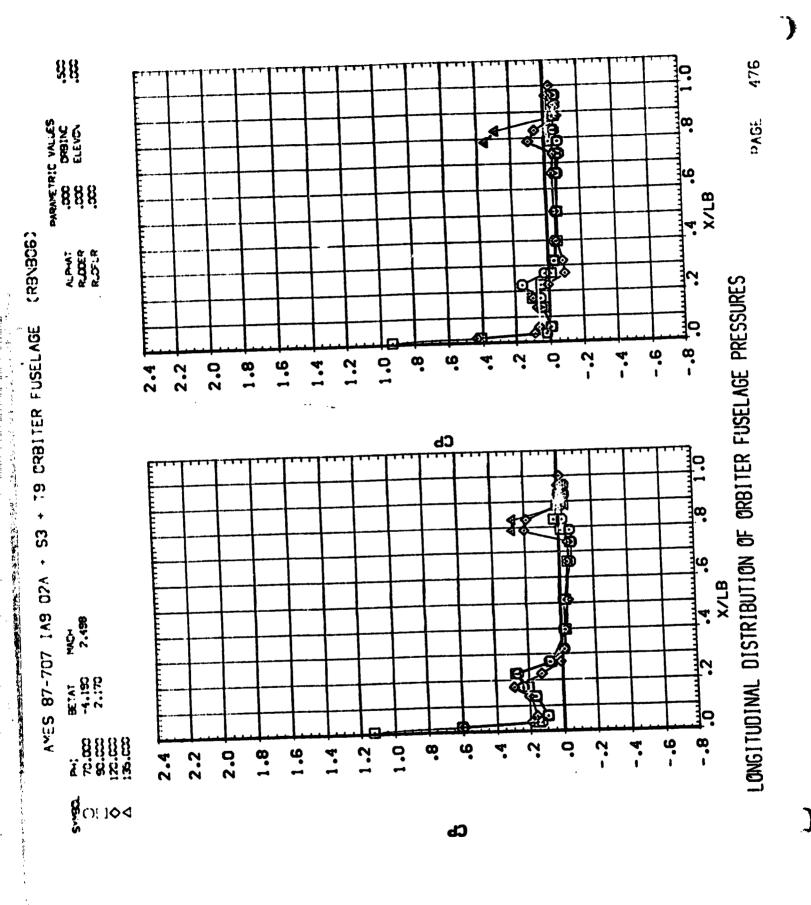
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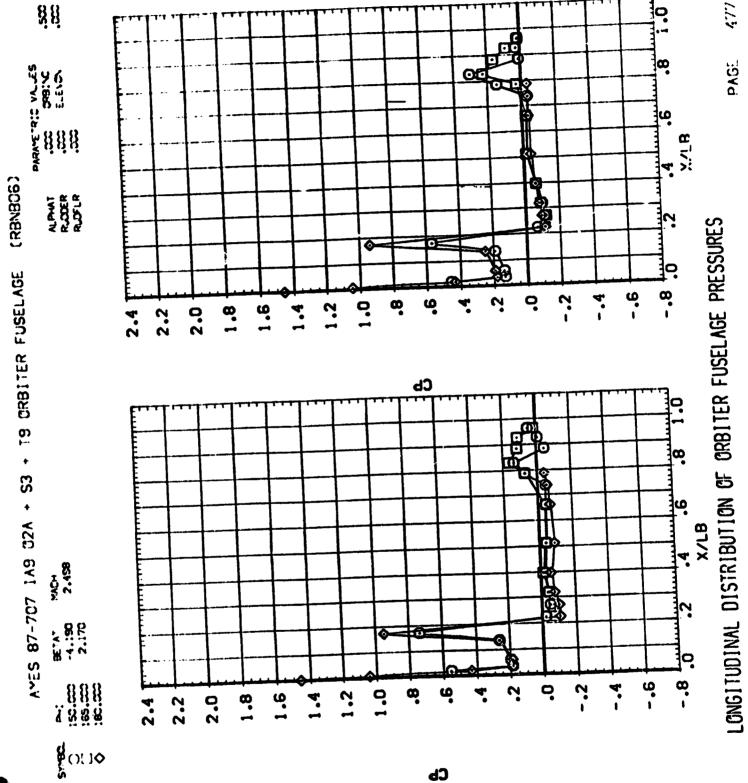


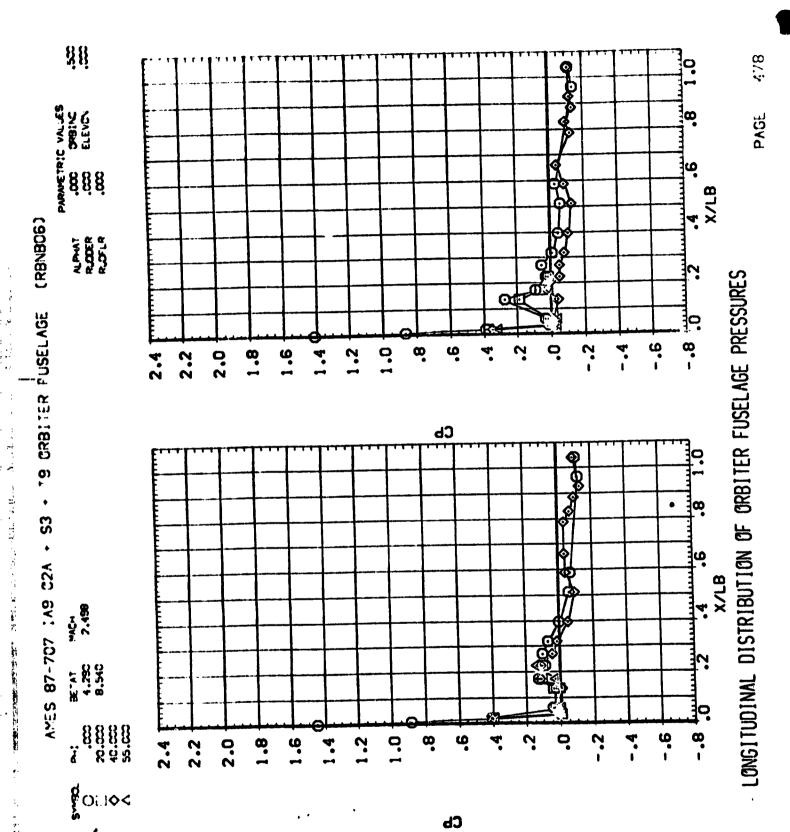










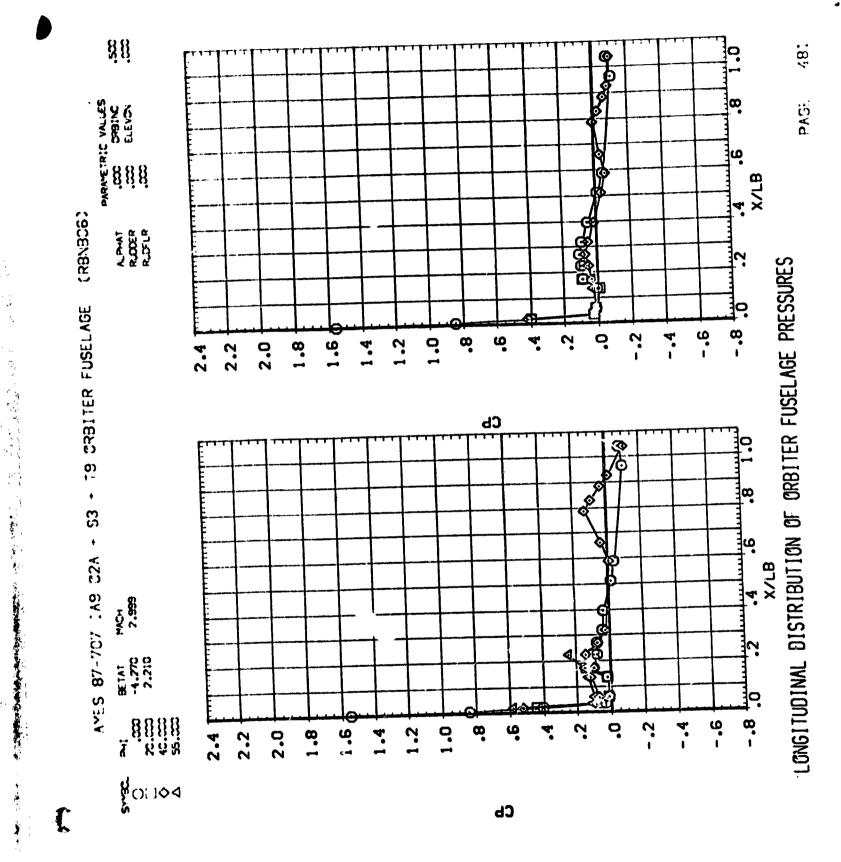


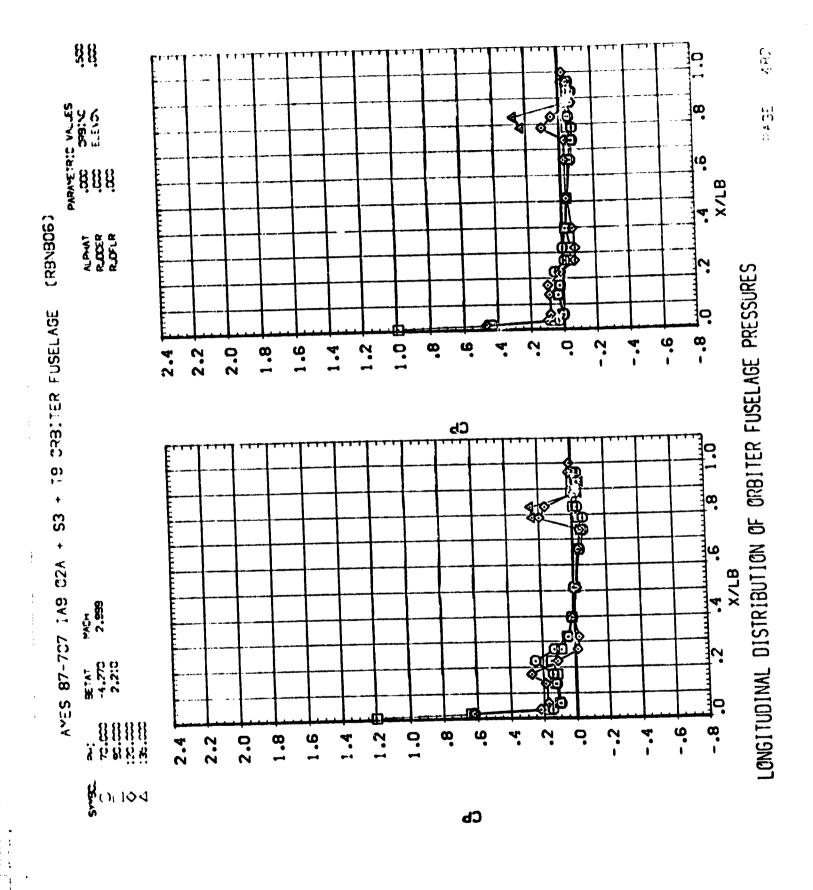
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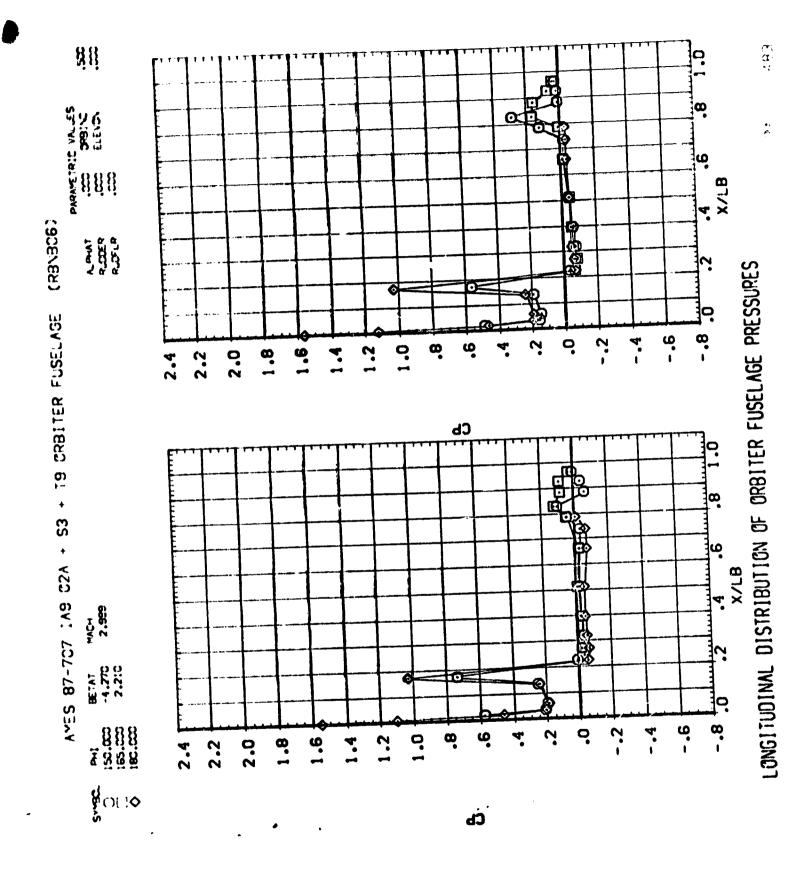
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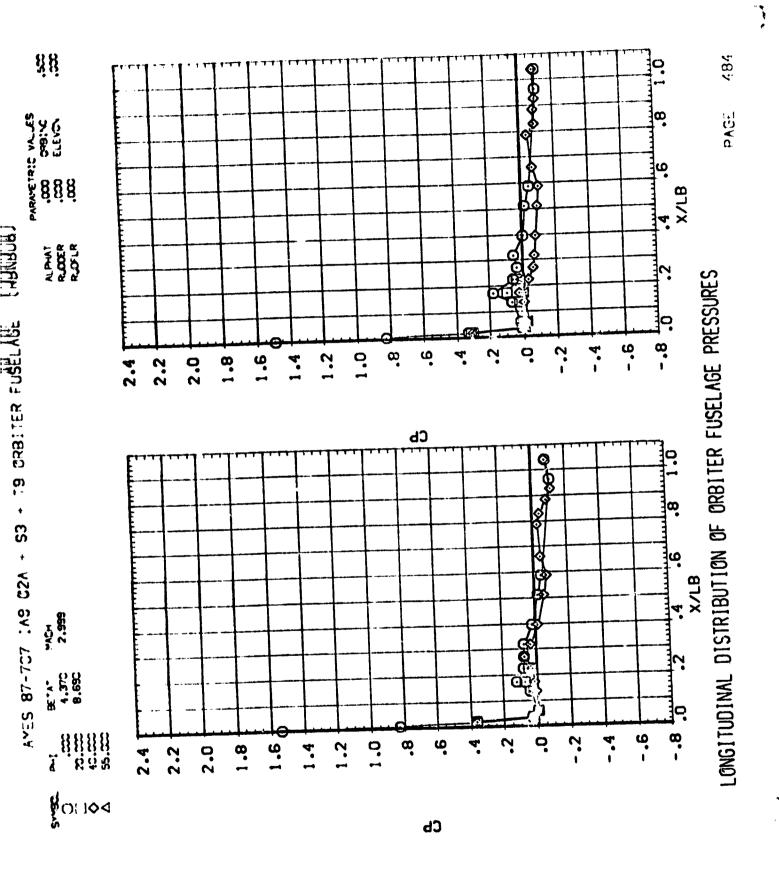
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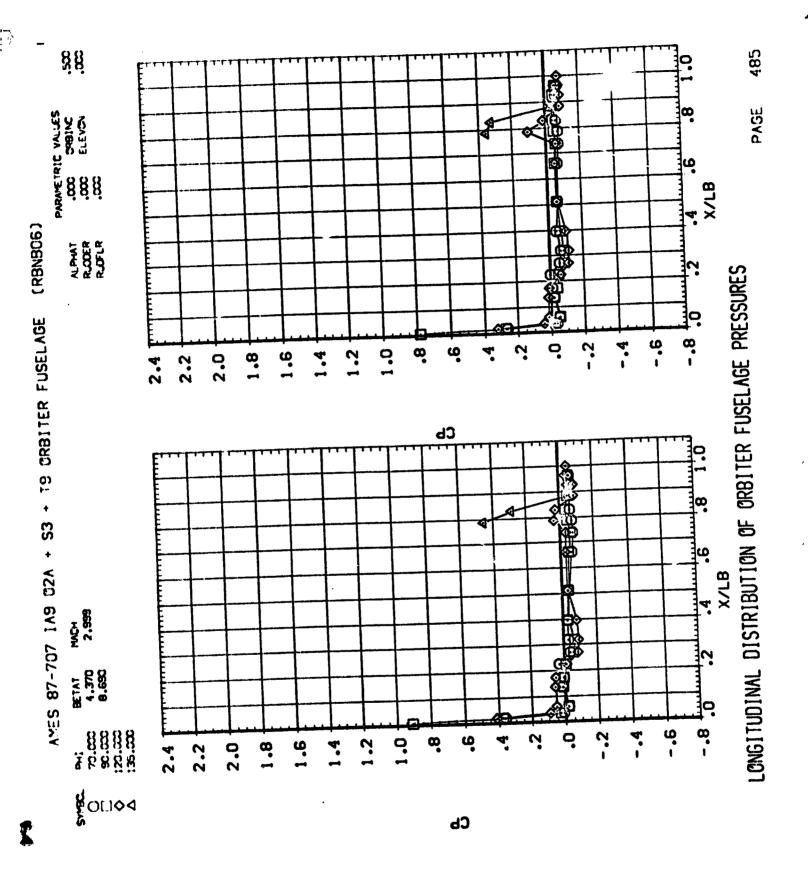
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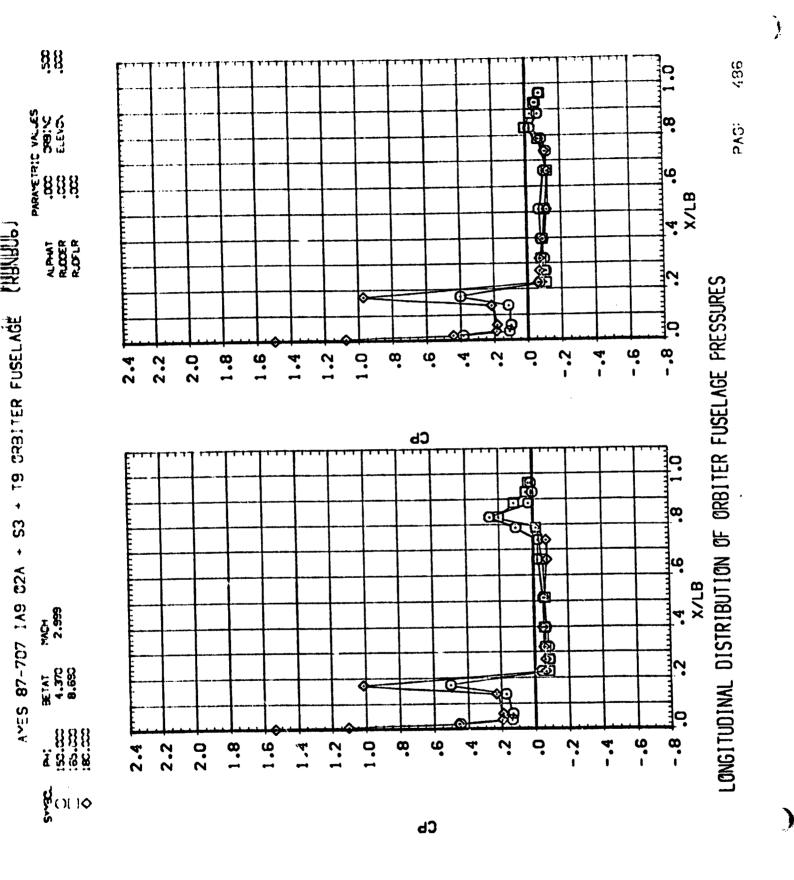




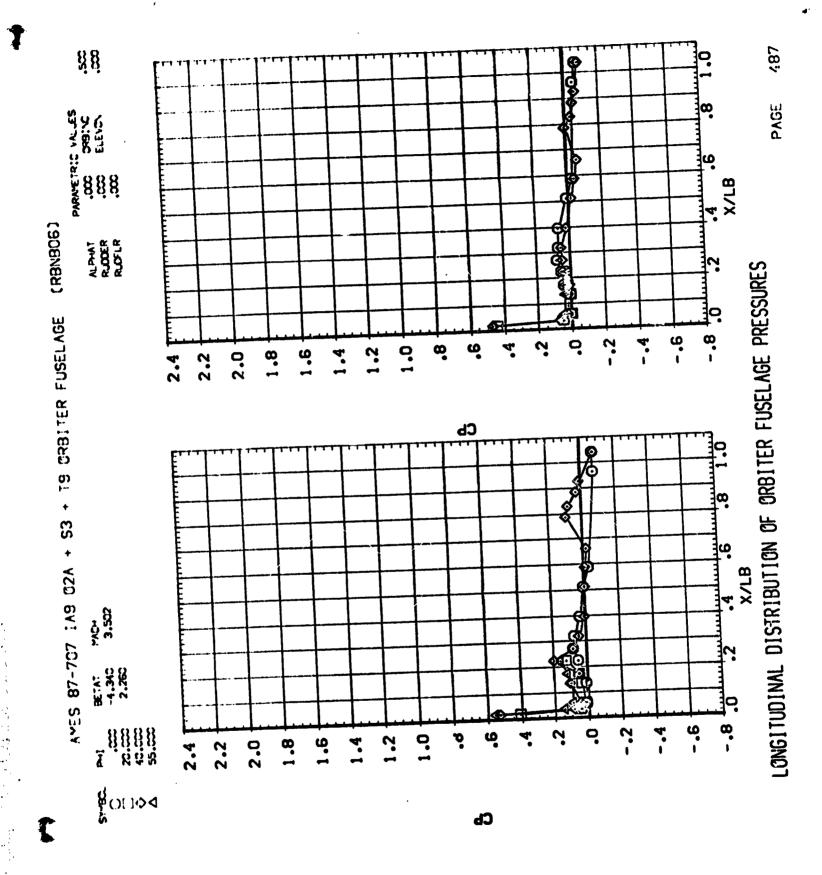






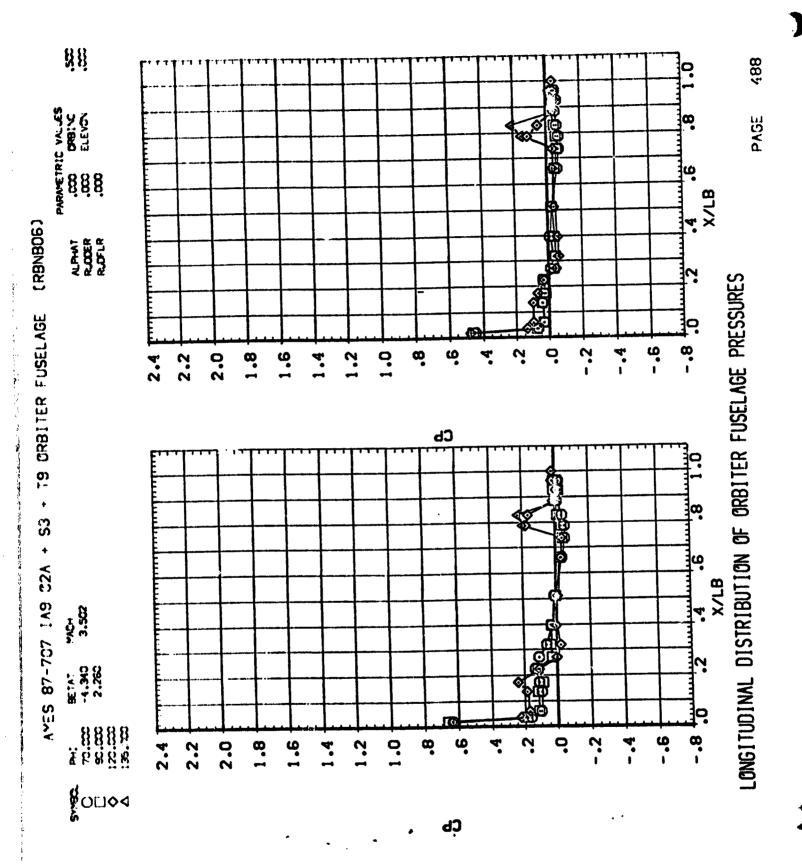


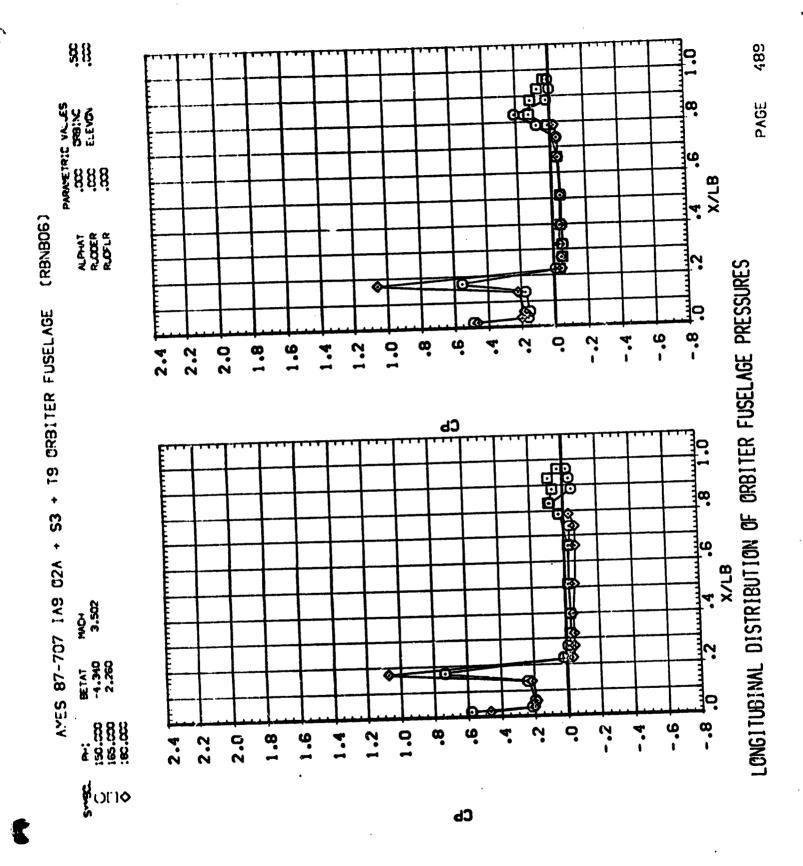
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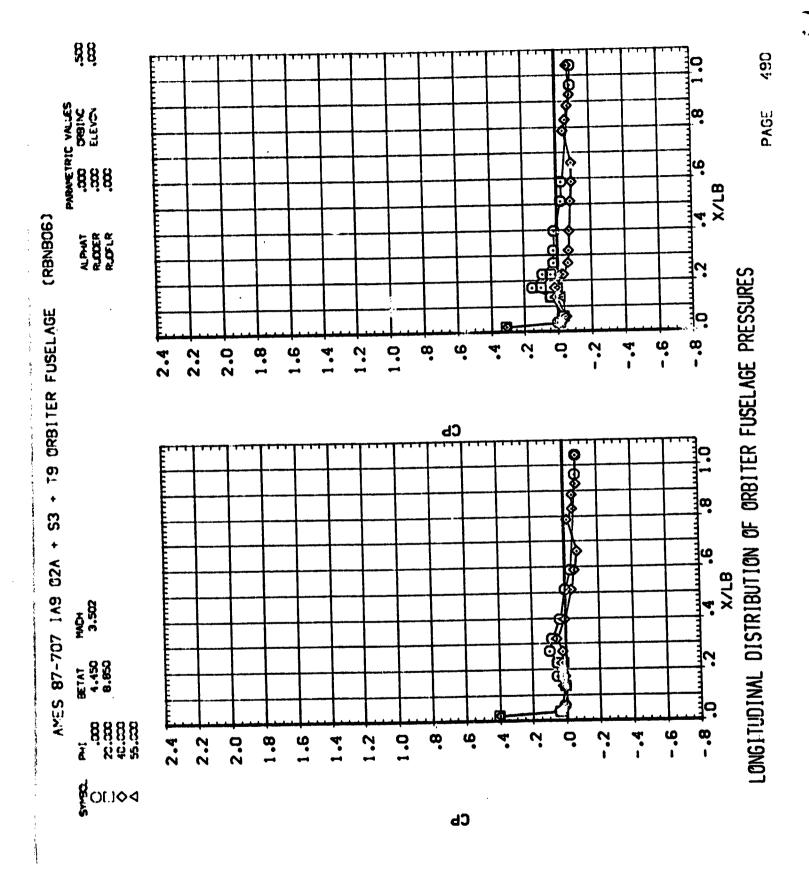


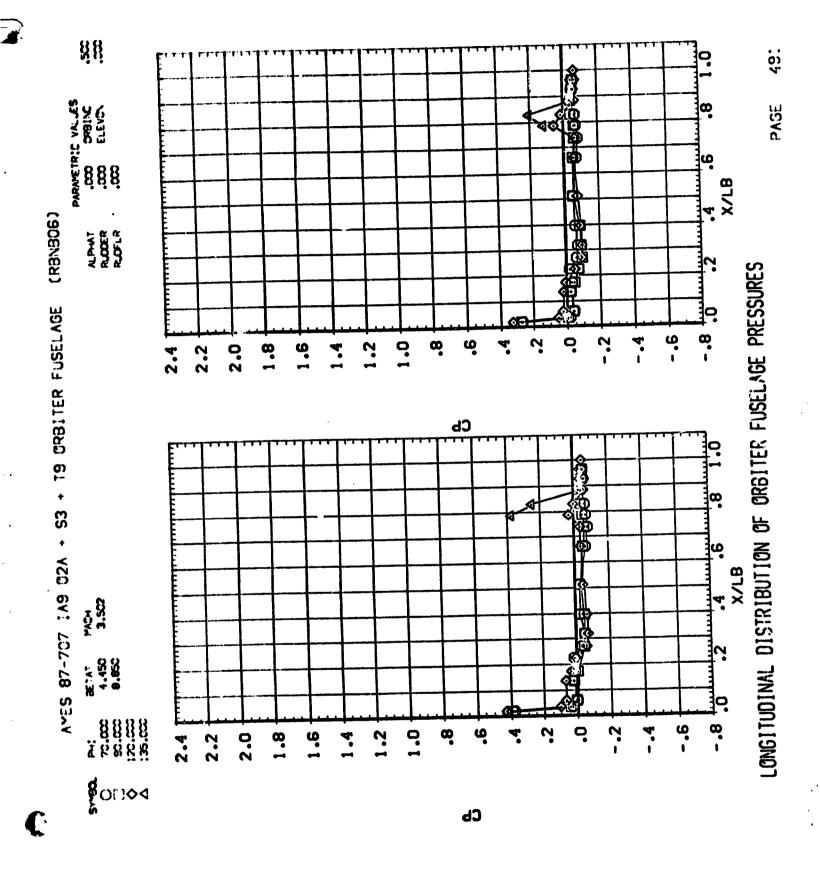
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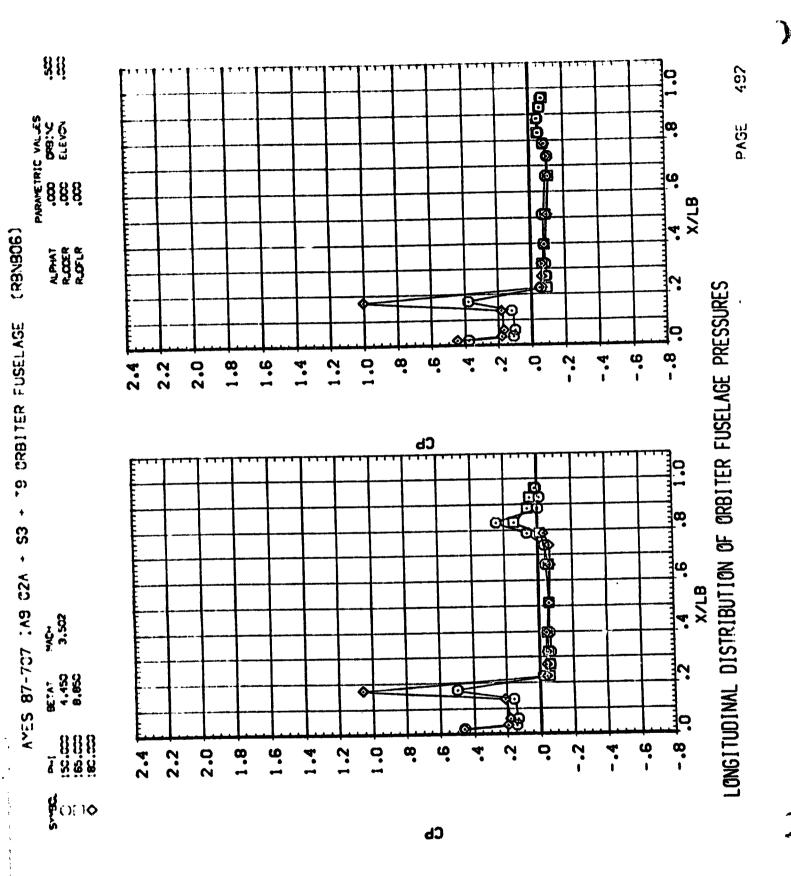
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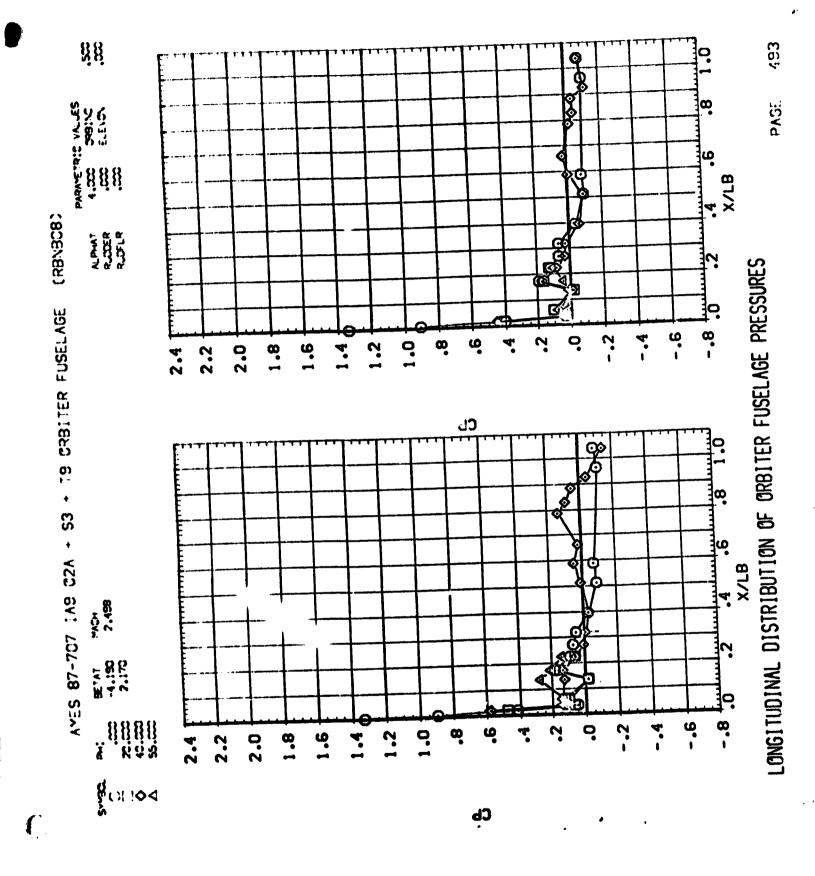


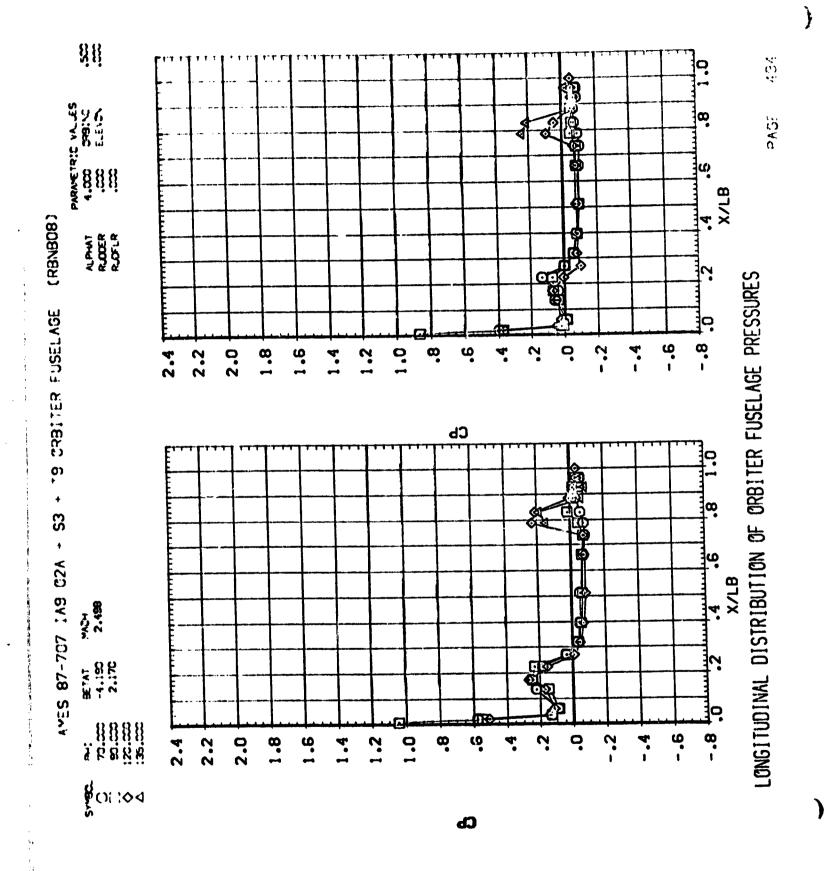








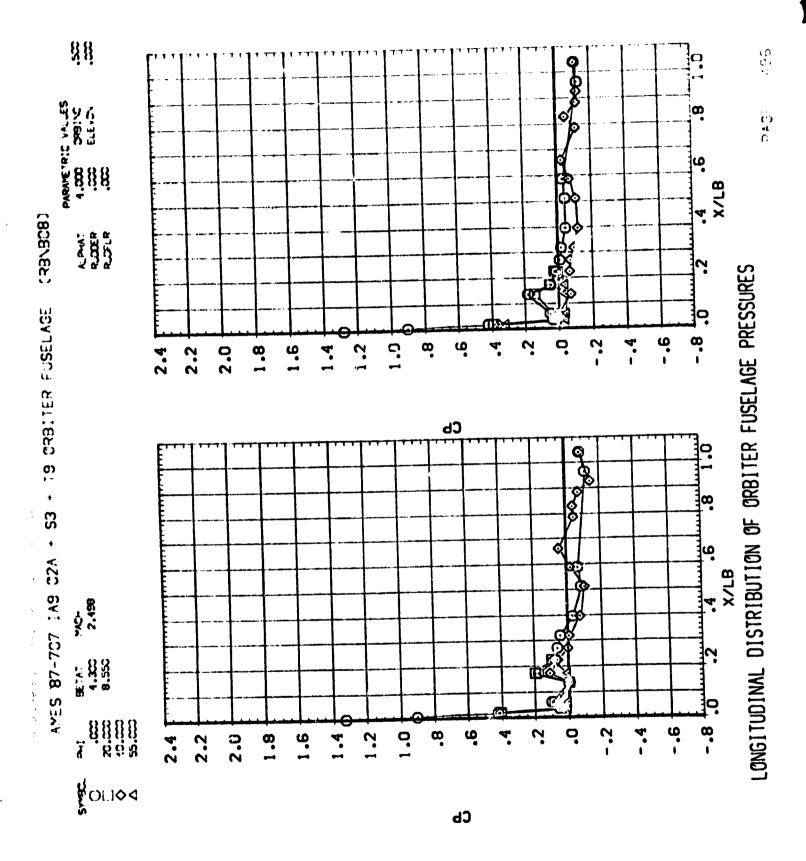


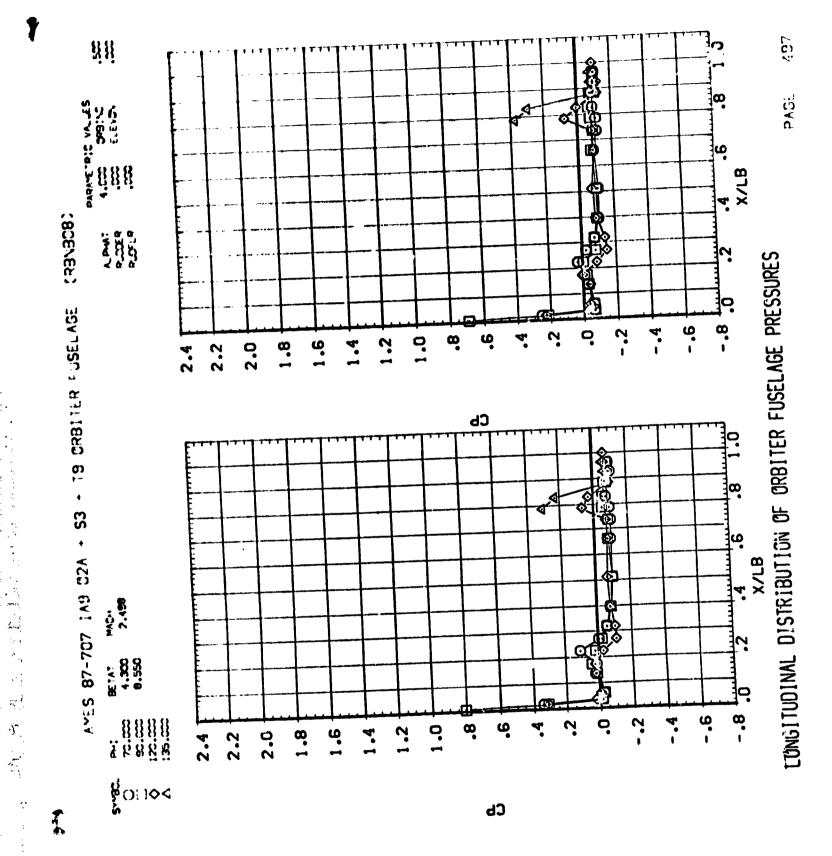


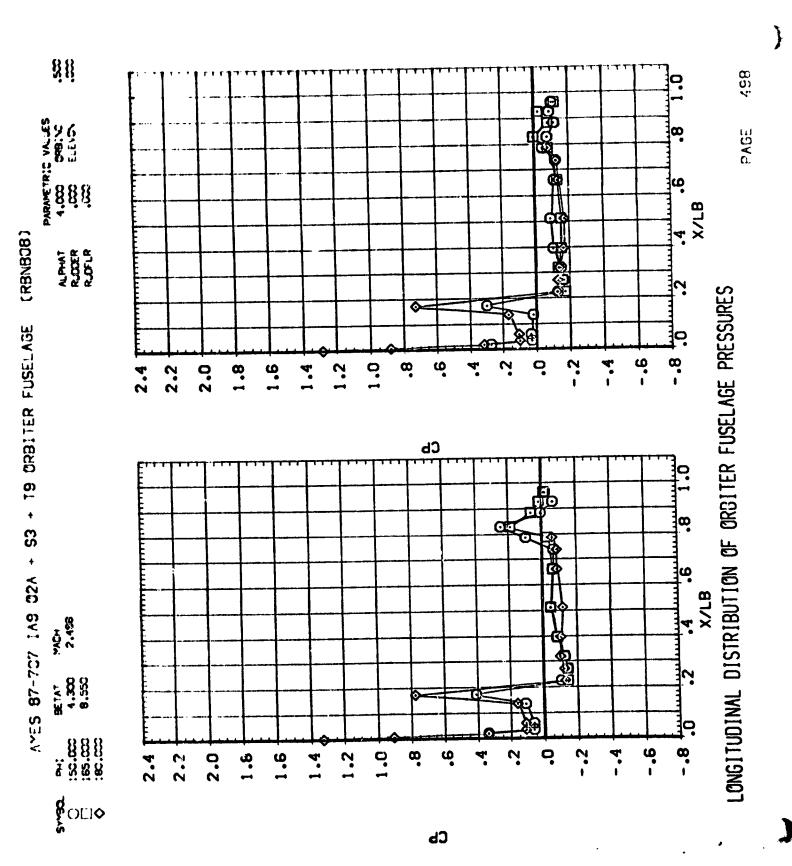
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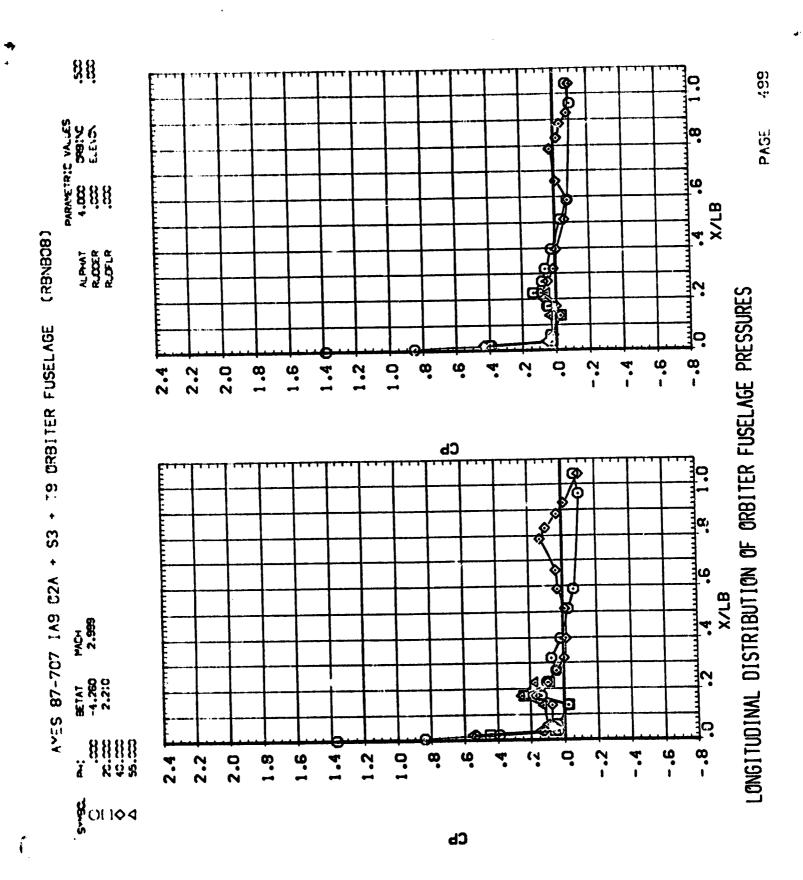
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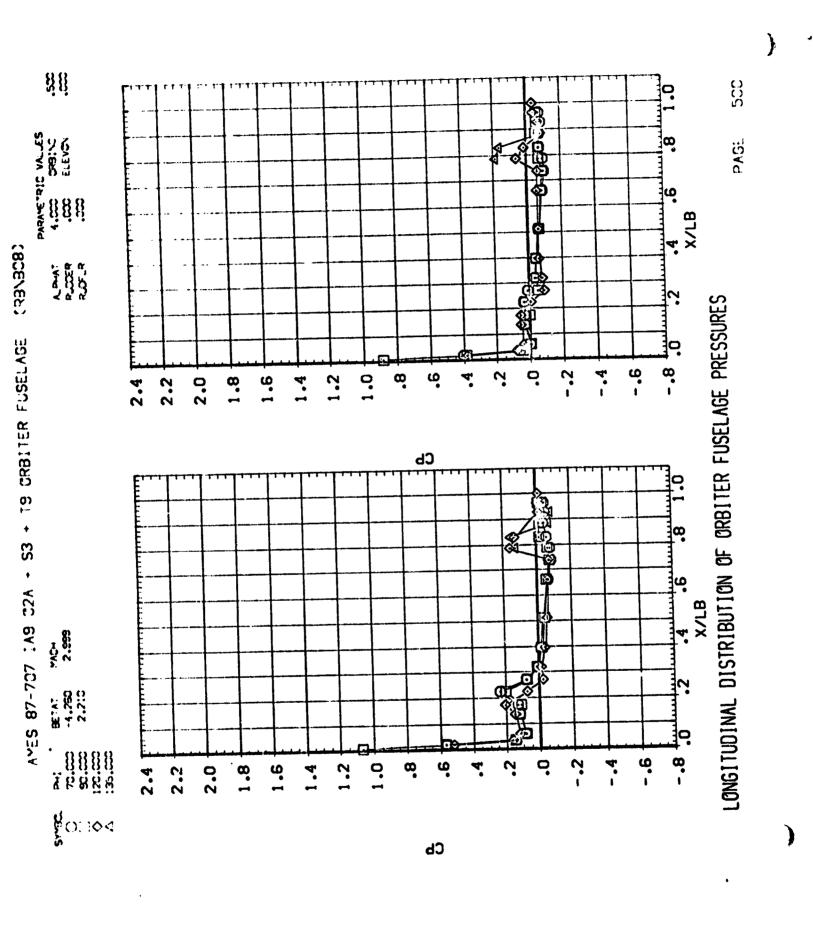
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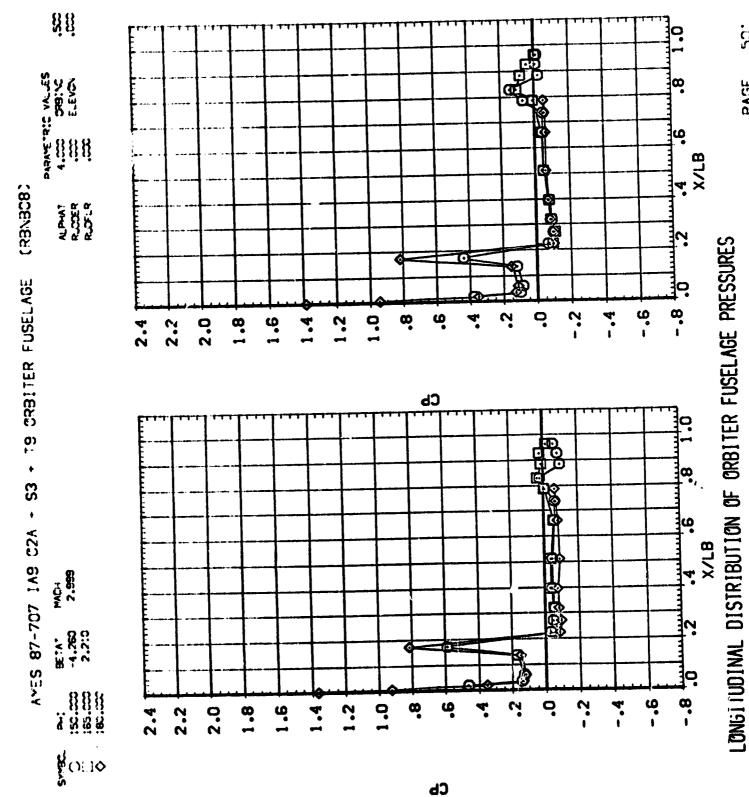








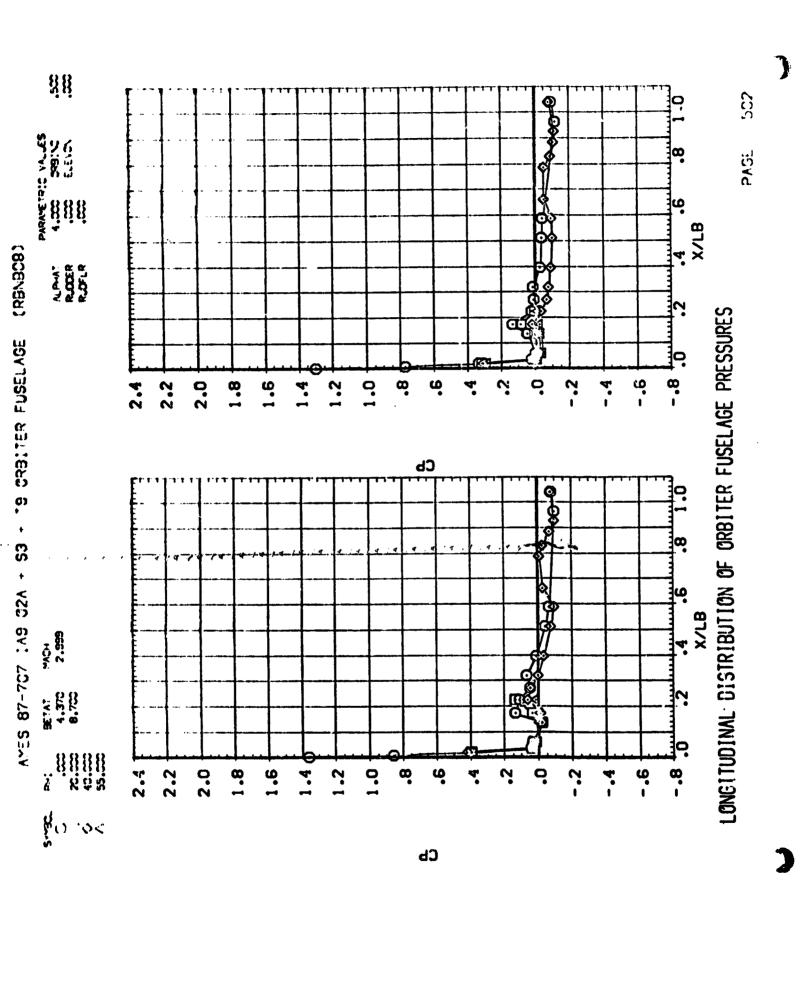


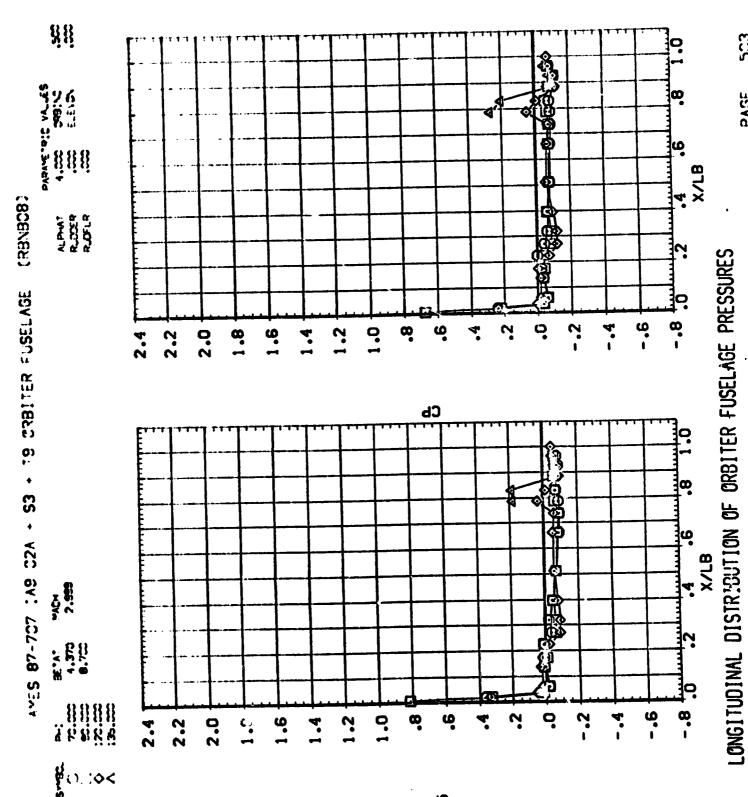


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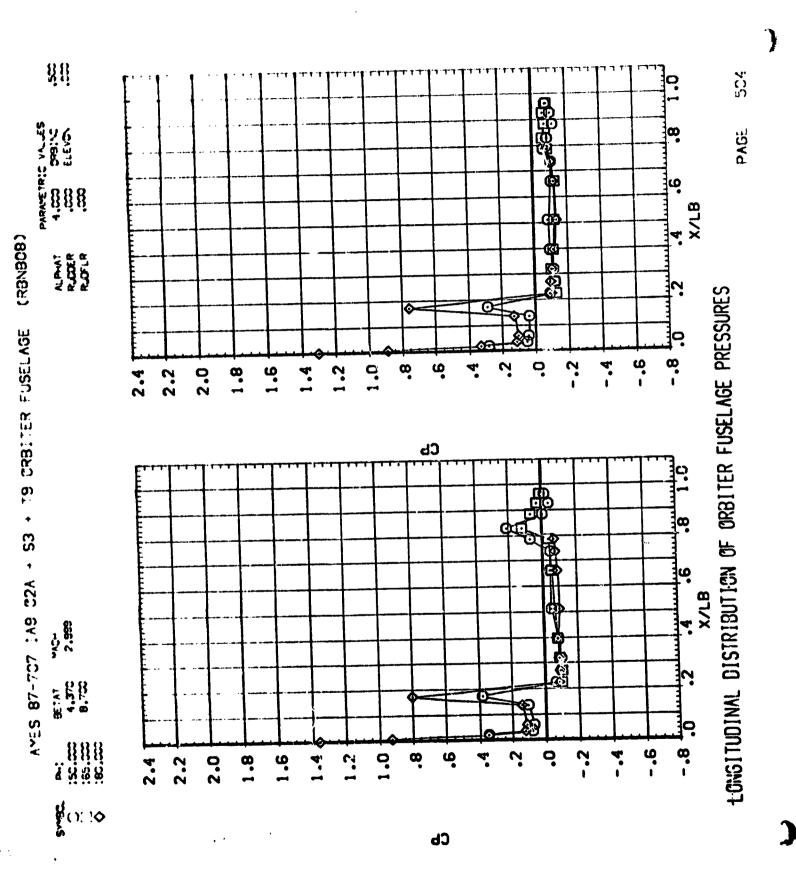
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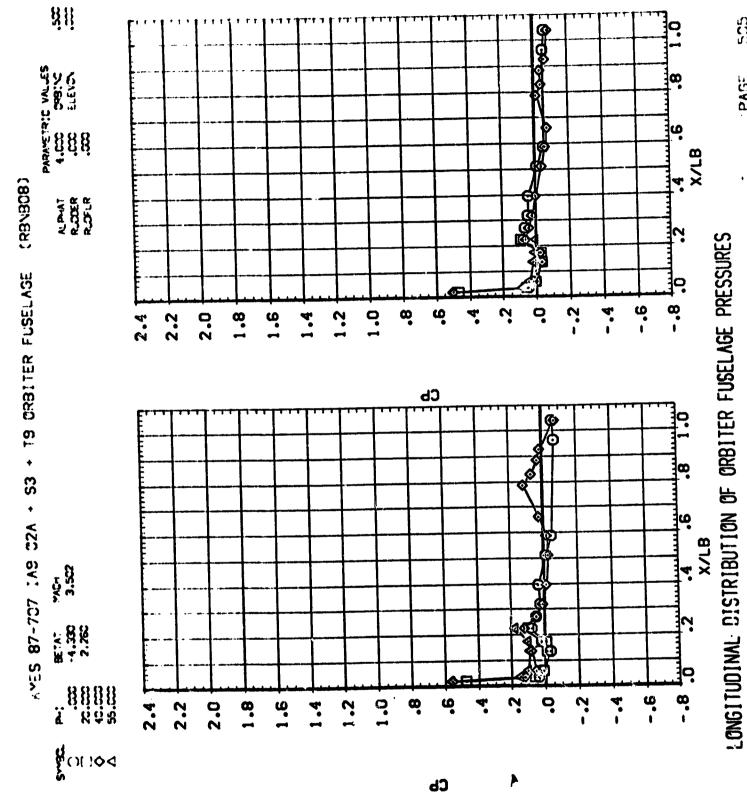
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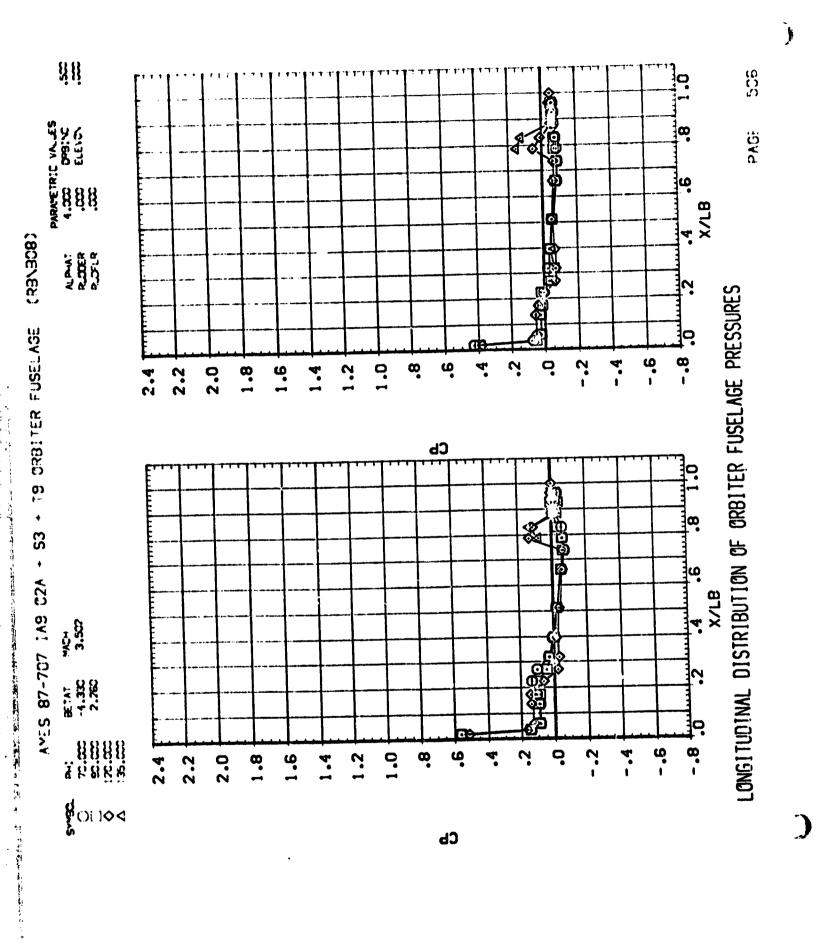


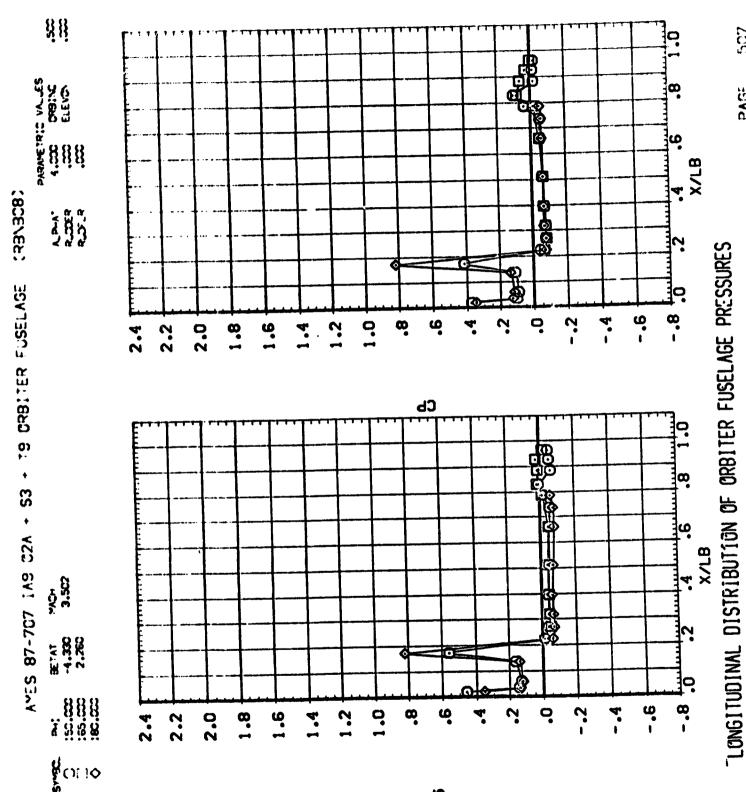


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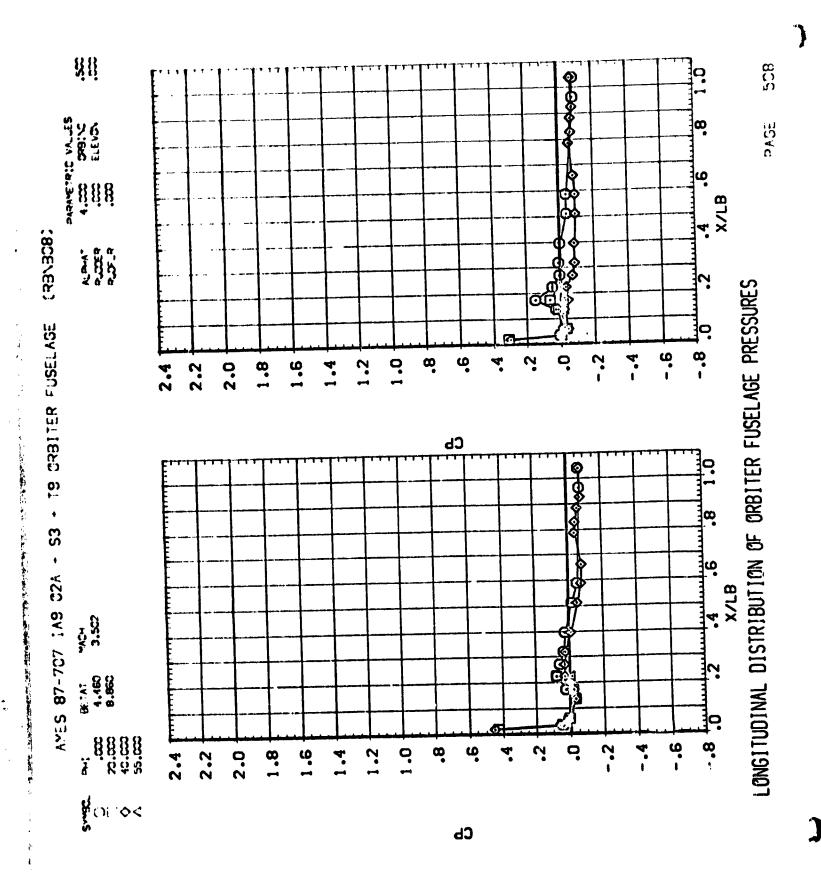






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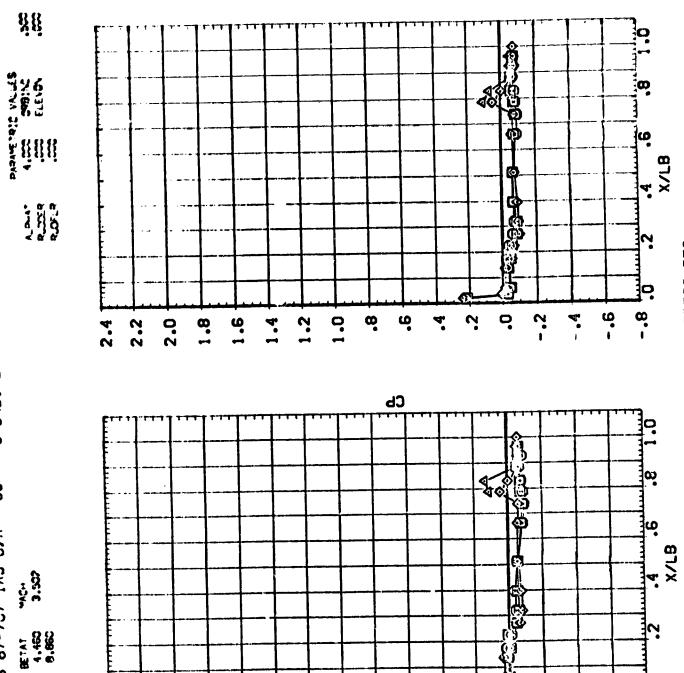
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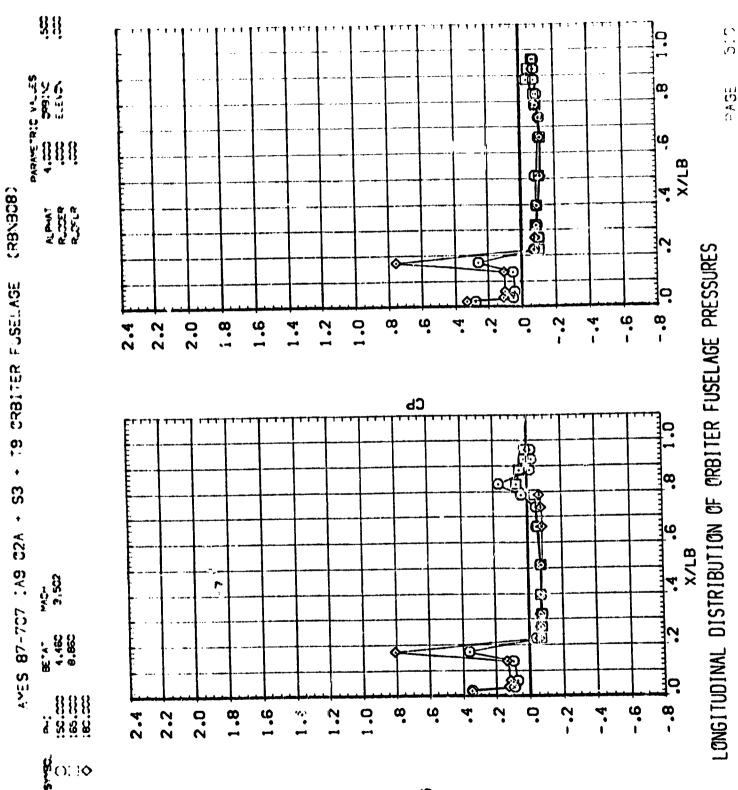
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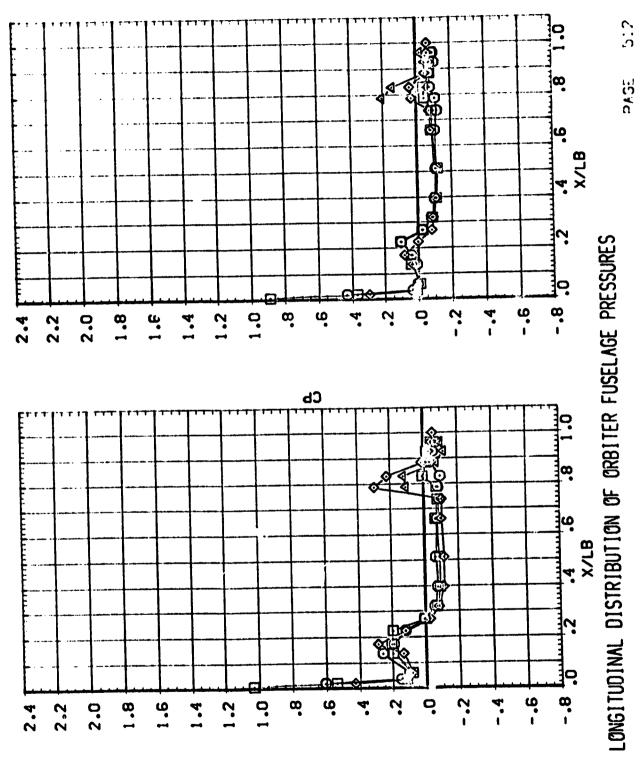
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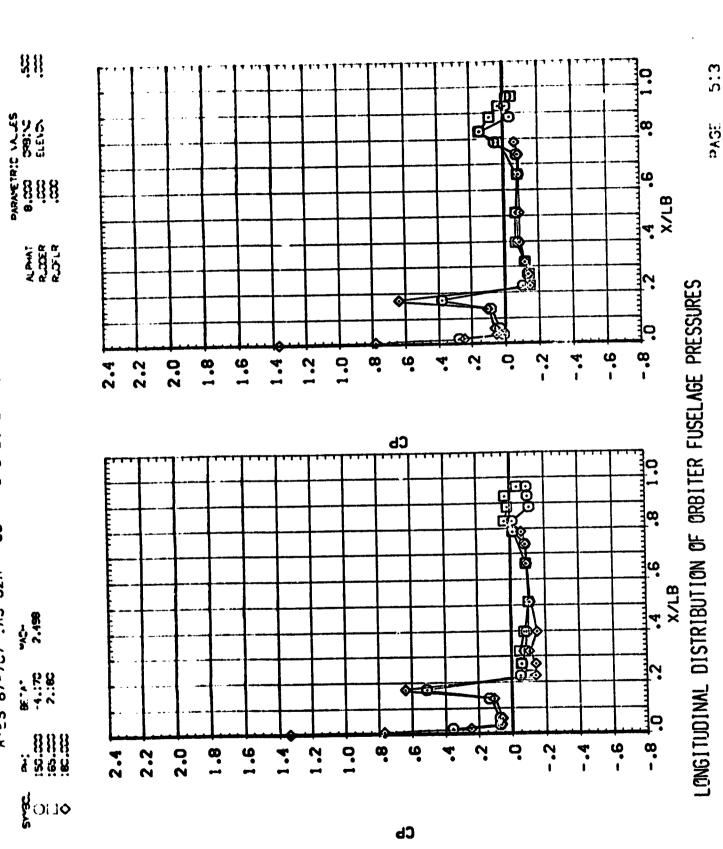


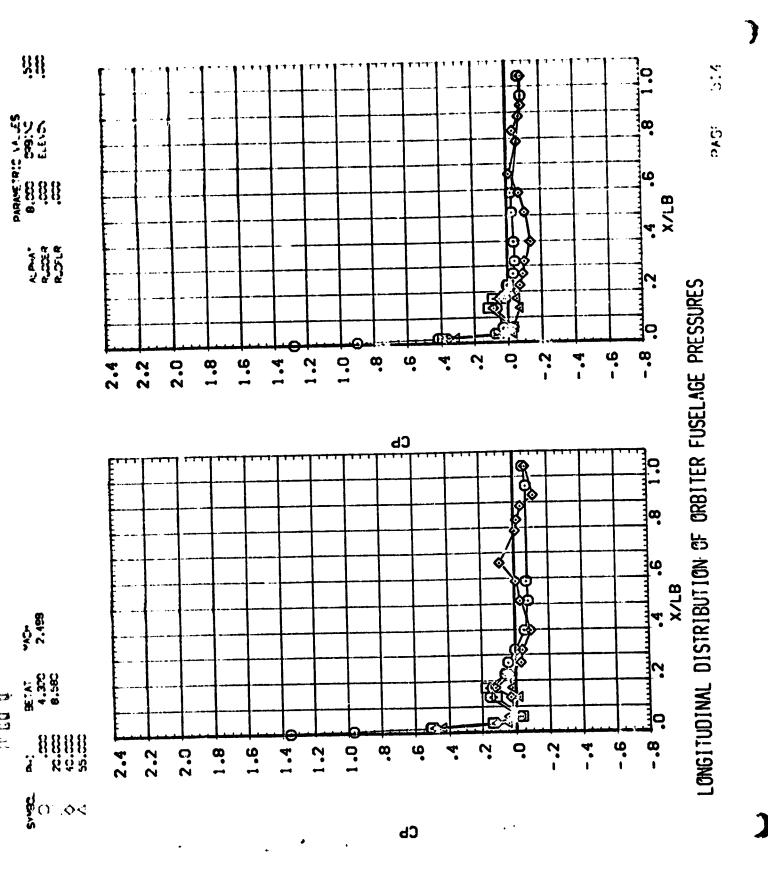
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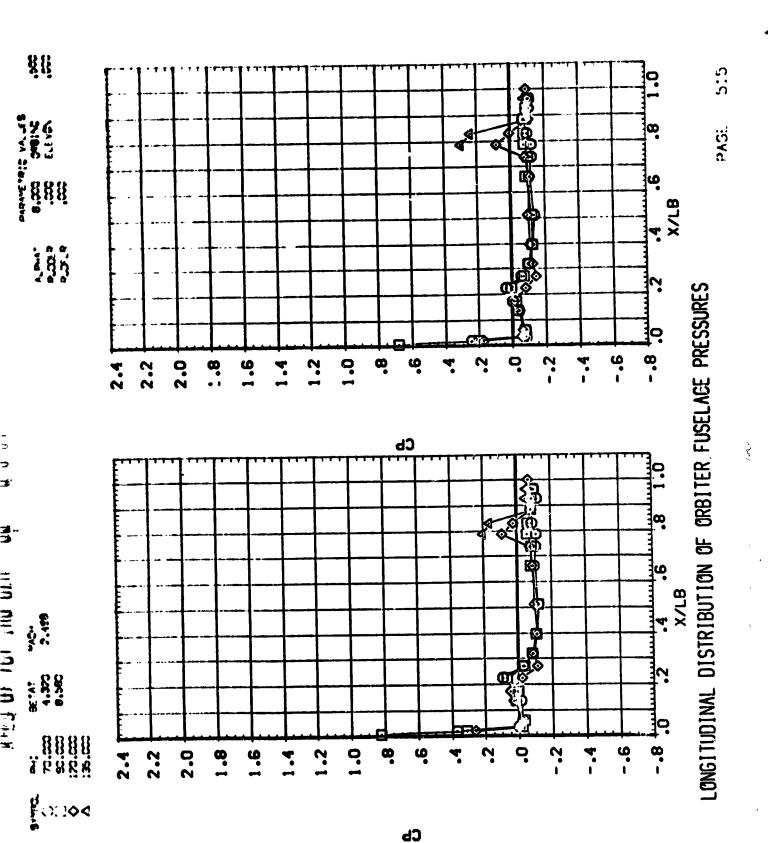
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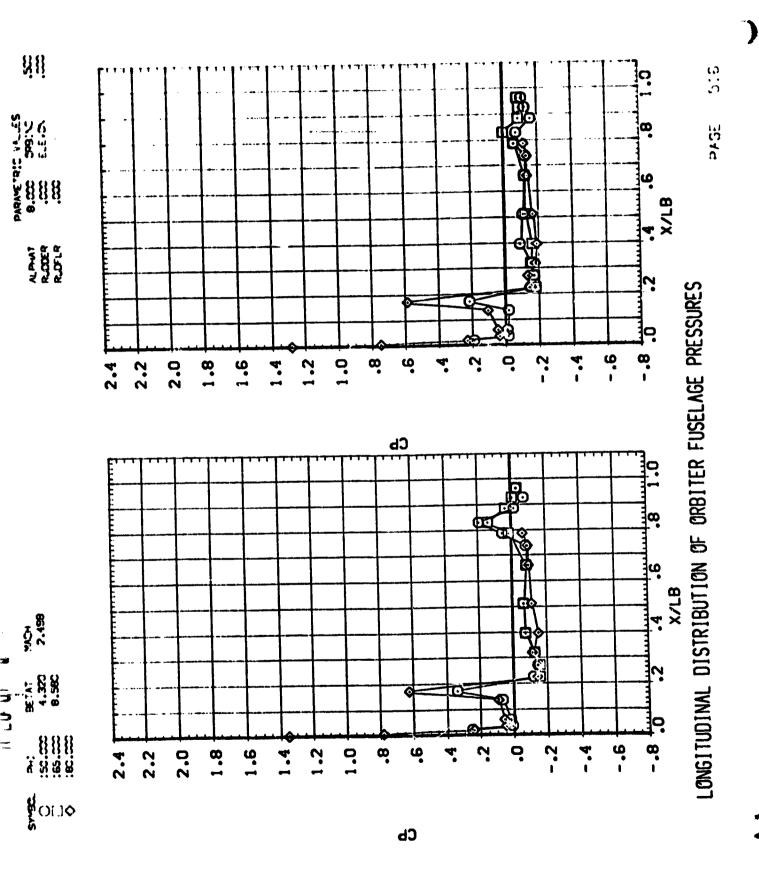
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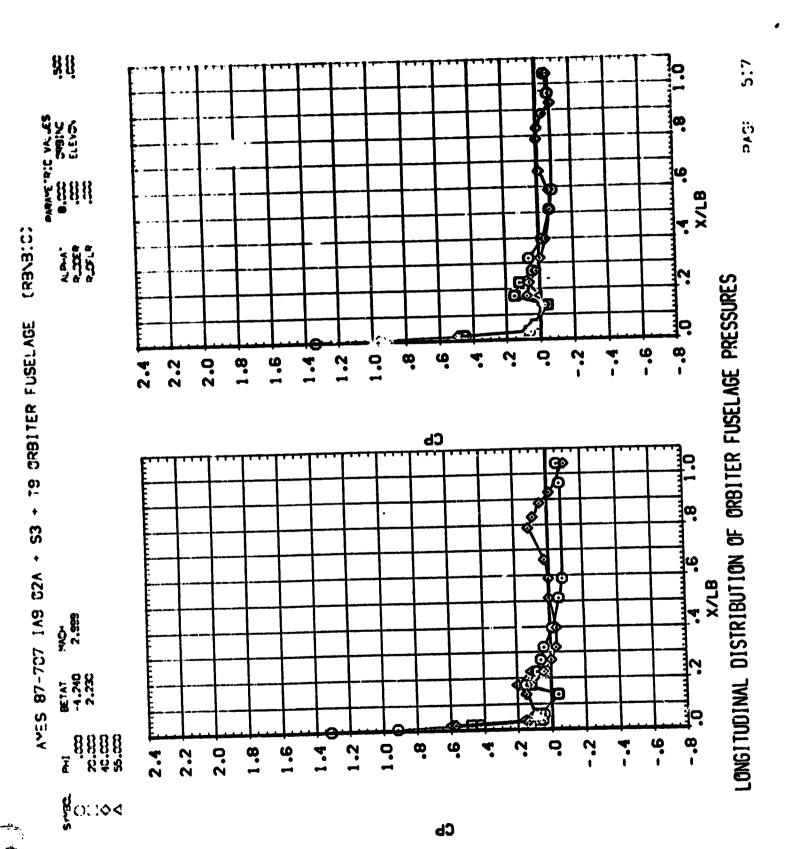
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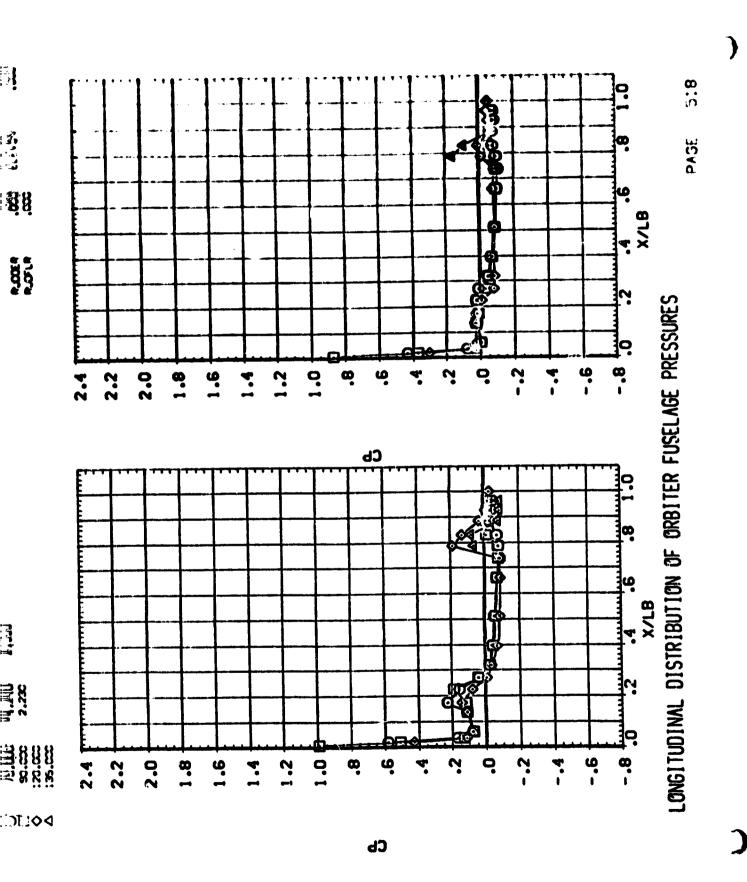


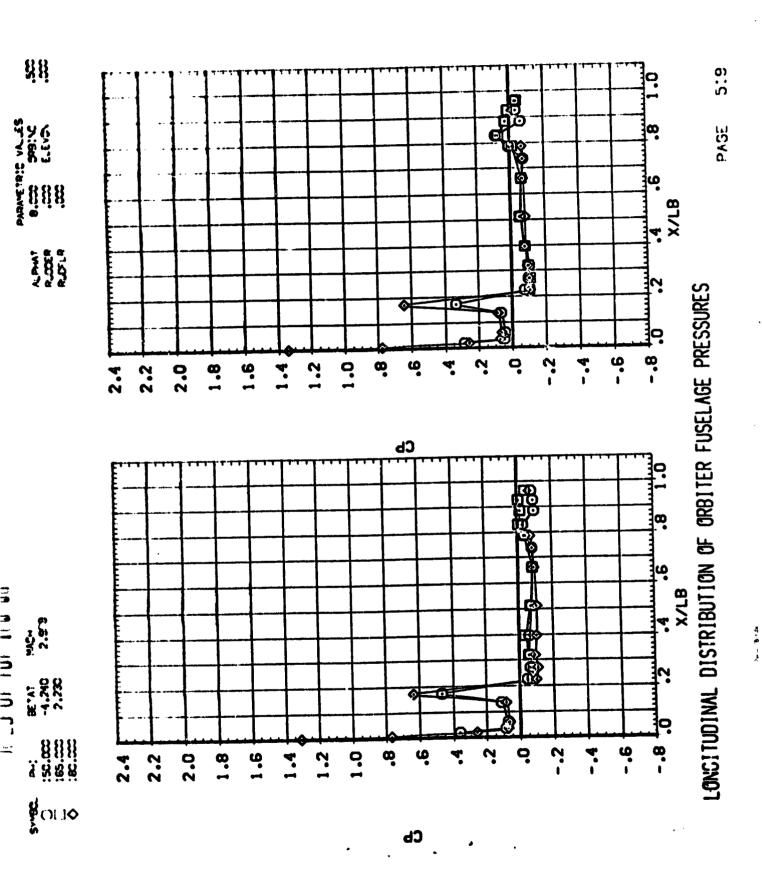












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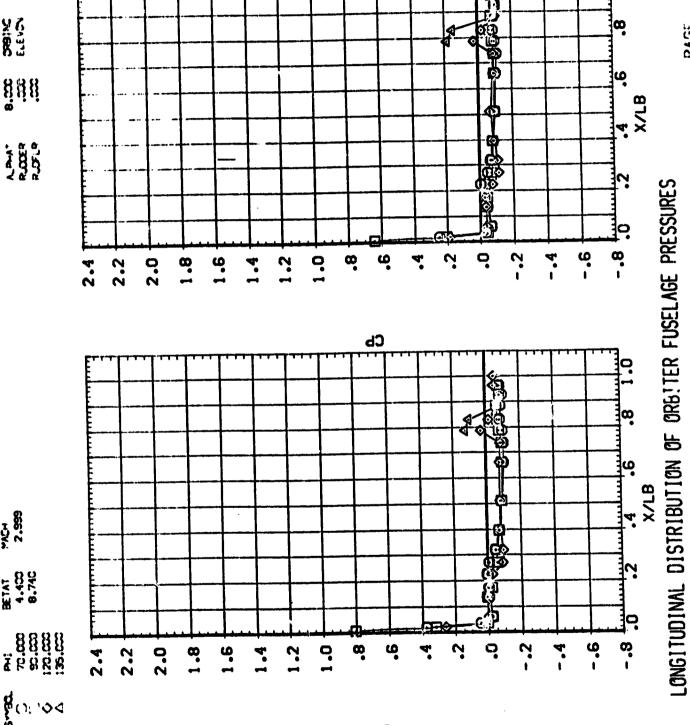
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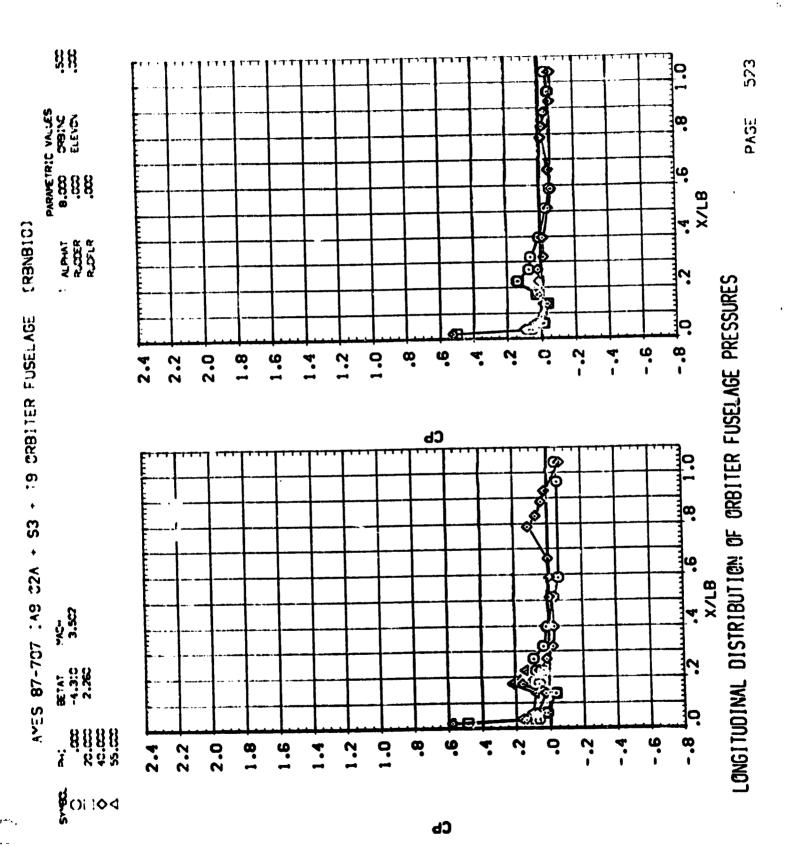


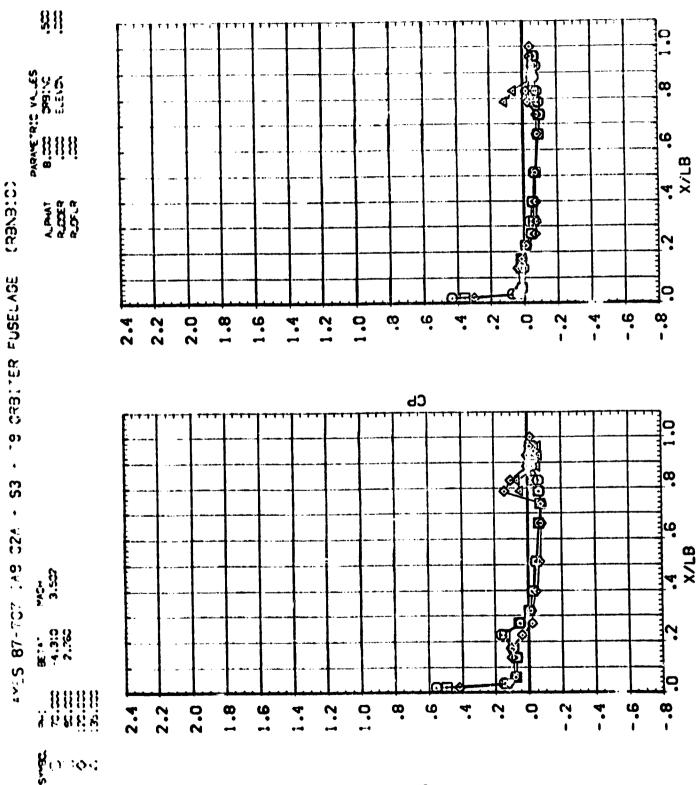
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LONGITUDINAL DISTRIBUTION OF ORBITER FUSELAGE PRESSURES

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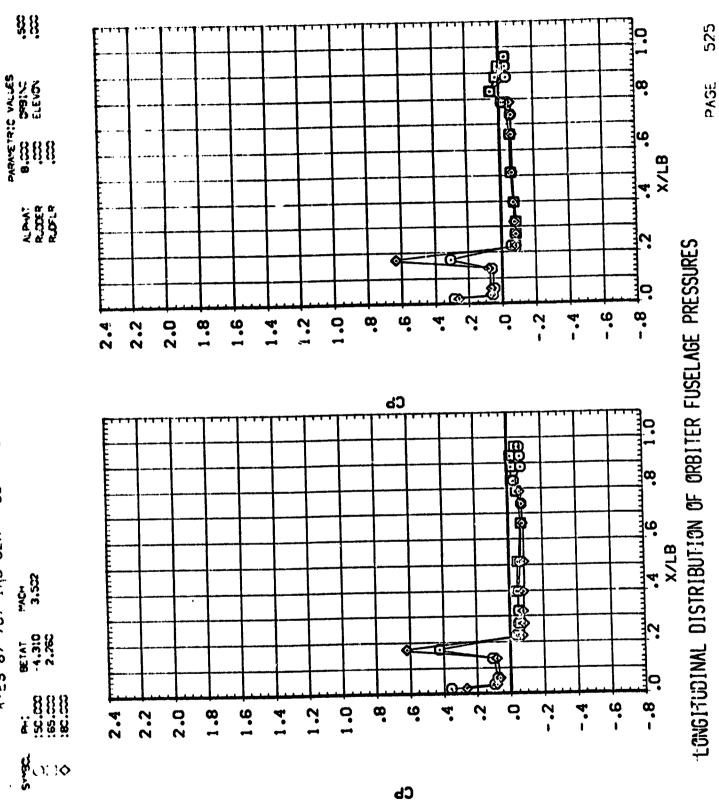
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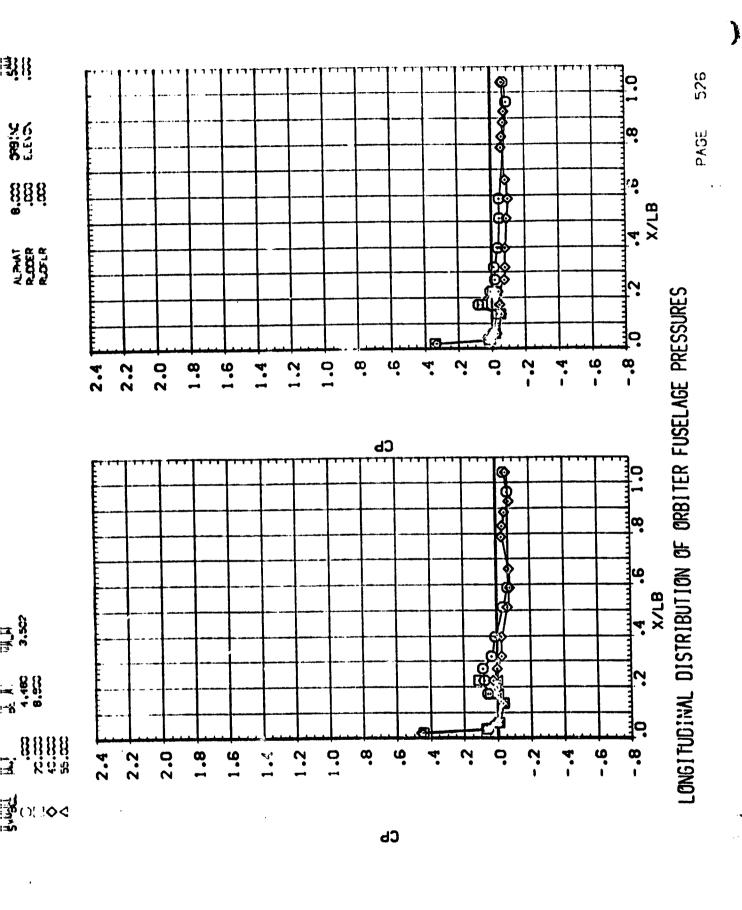


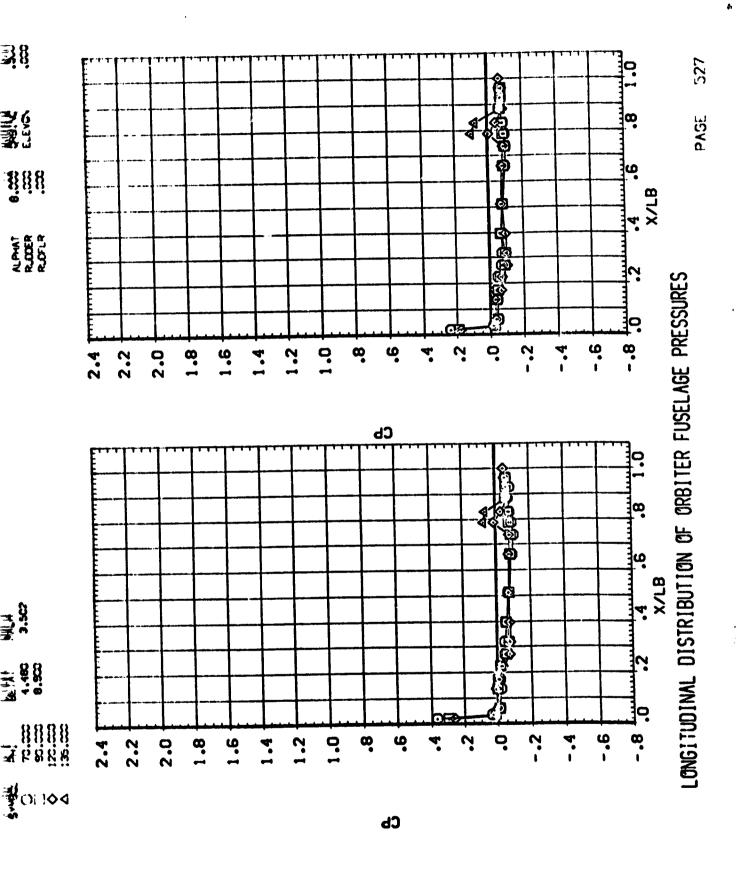
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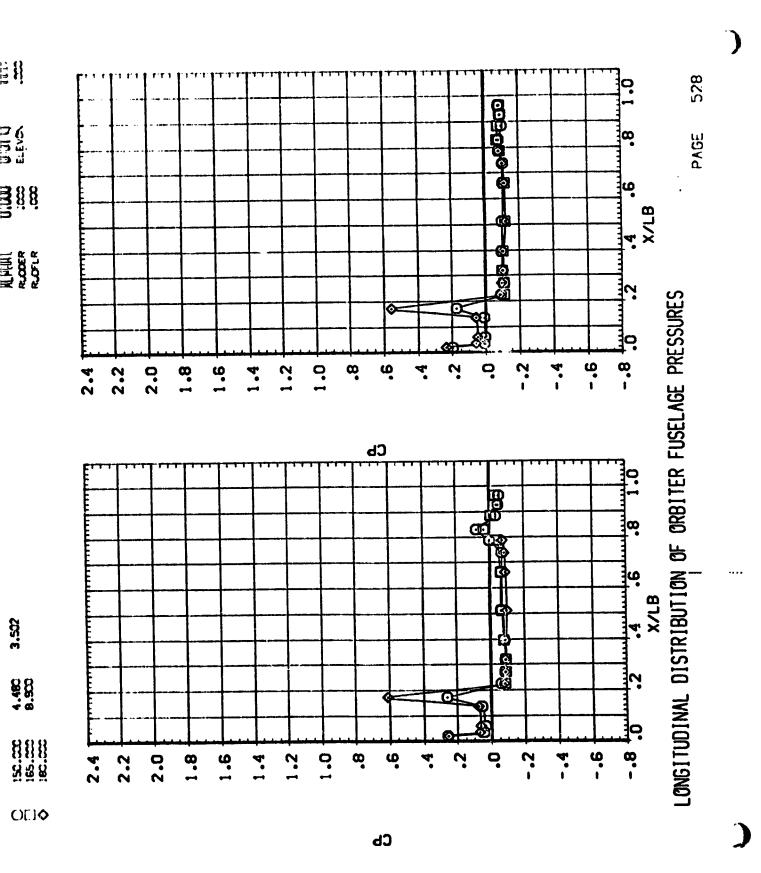
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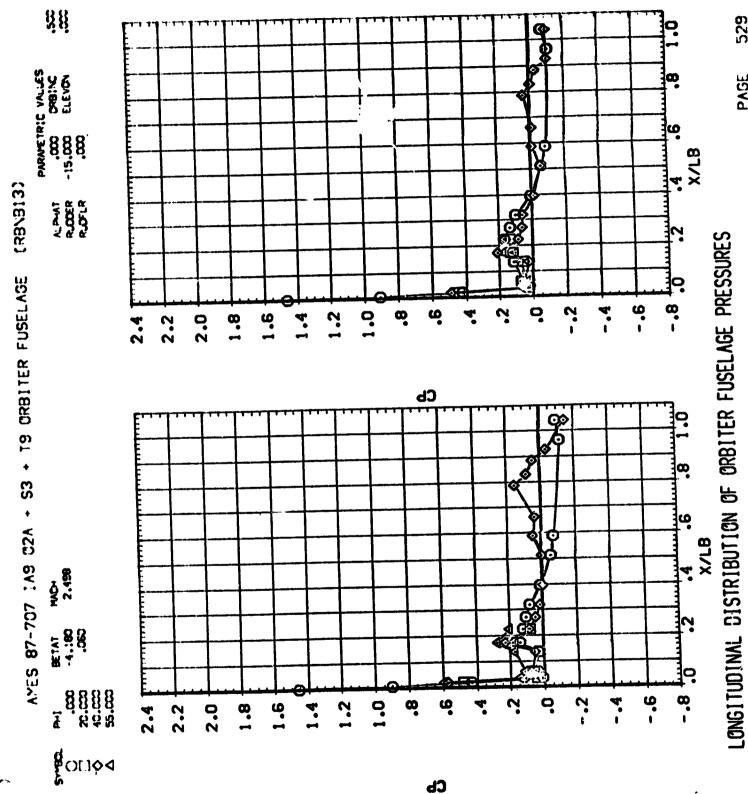


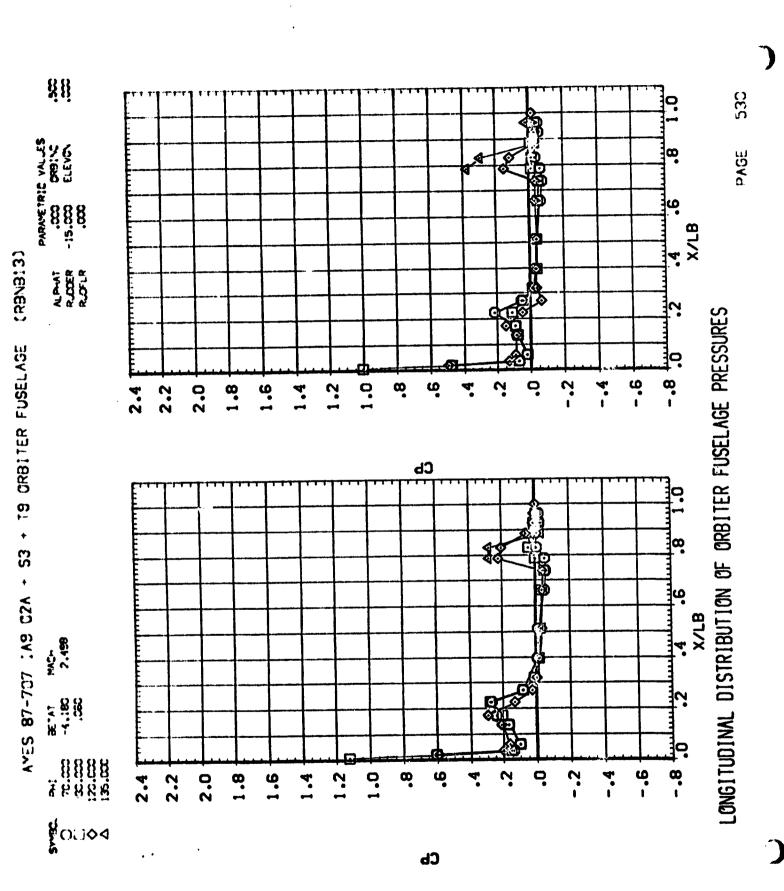
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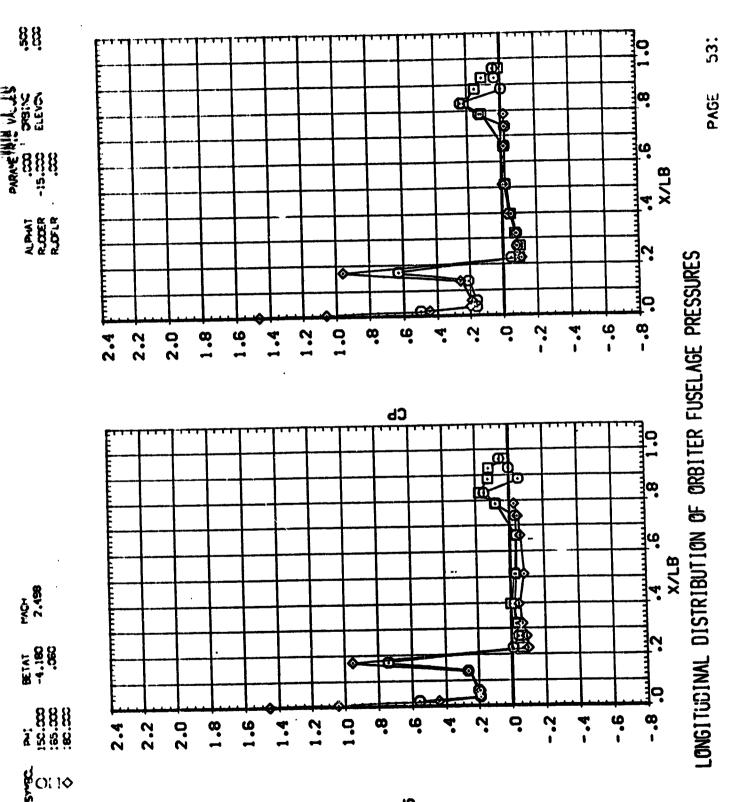


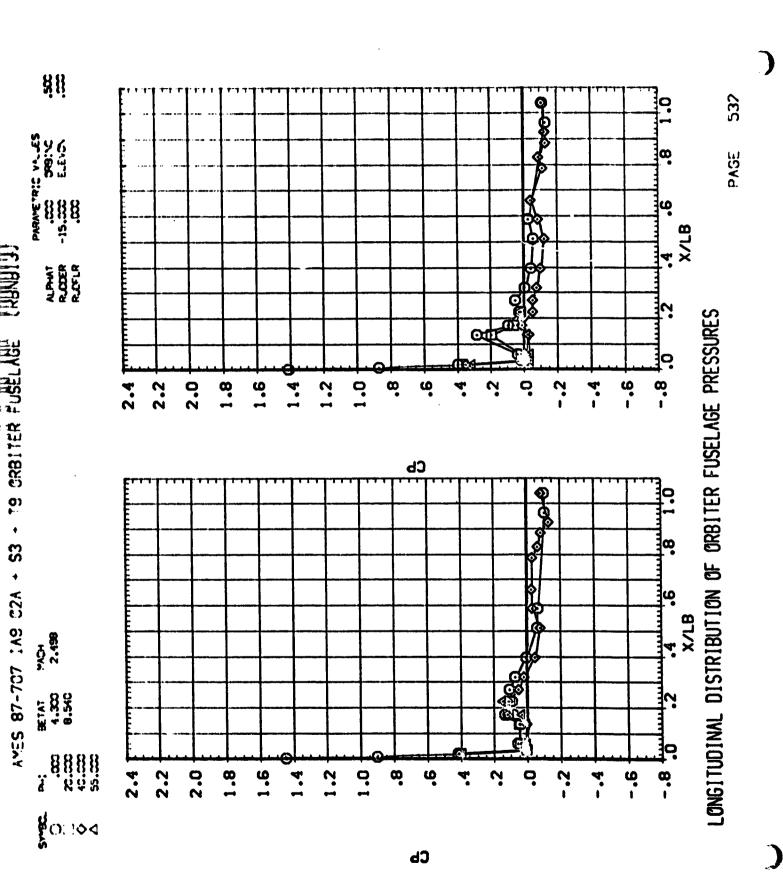










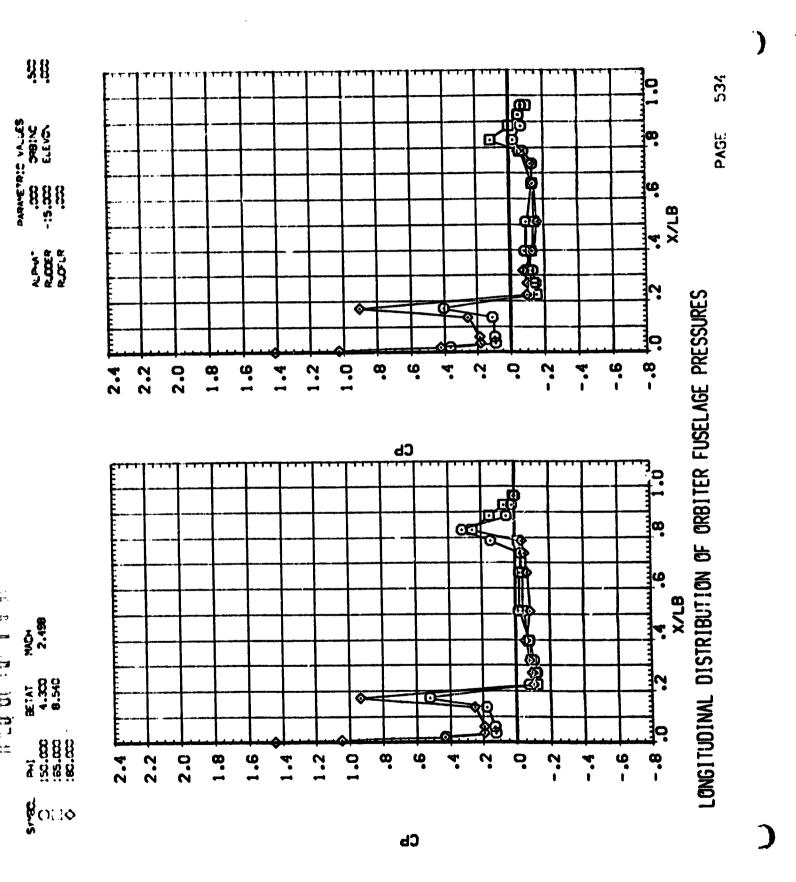


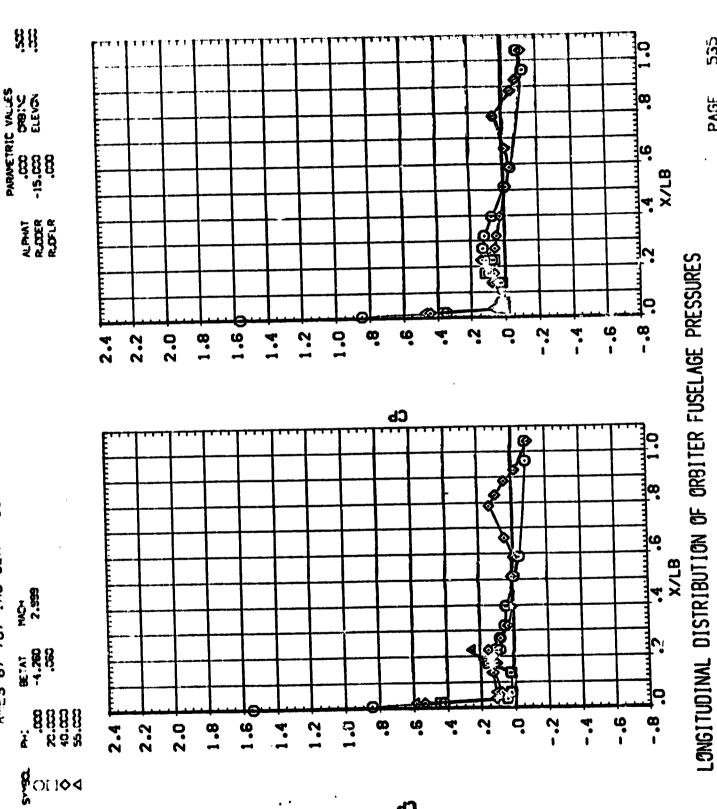
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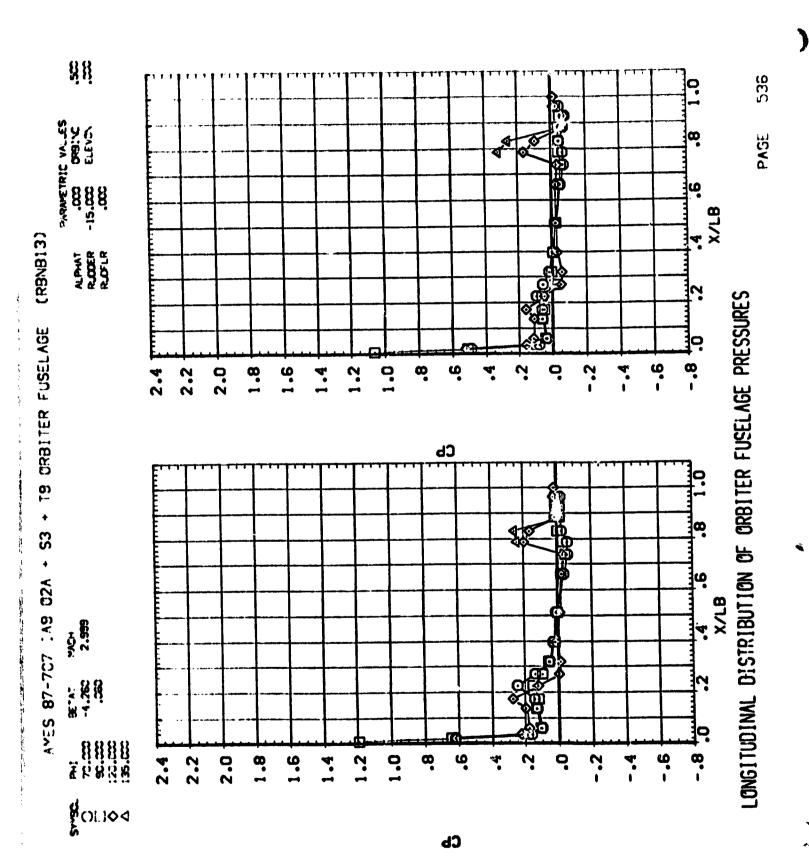


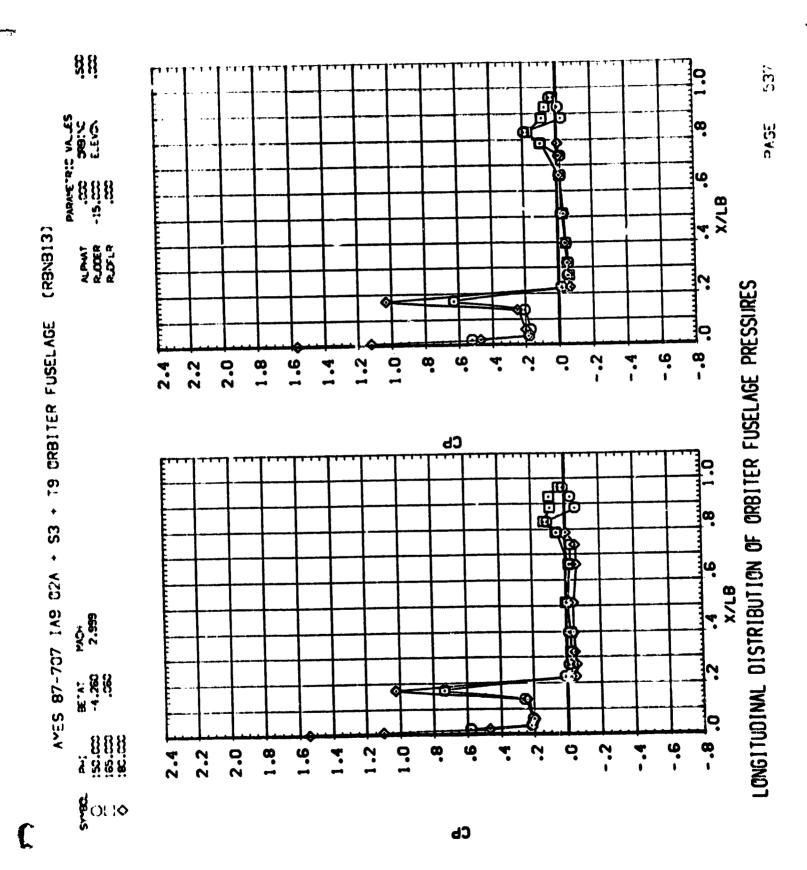


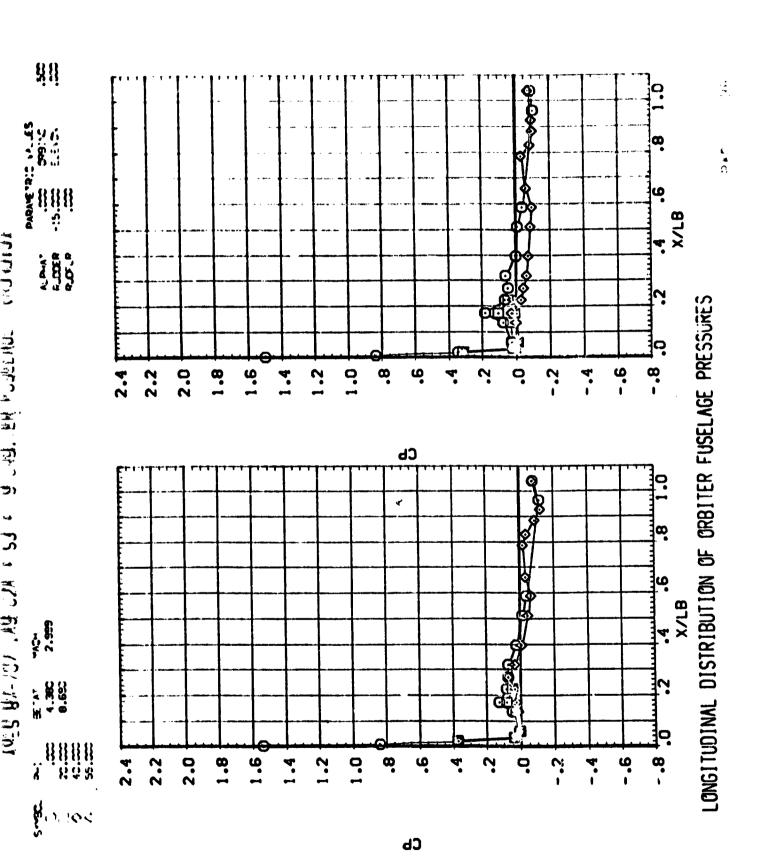
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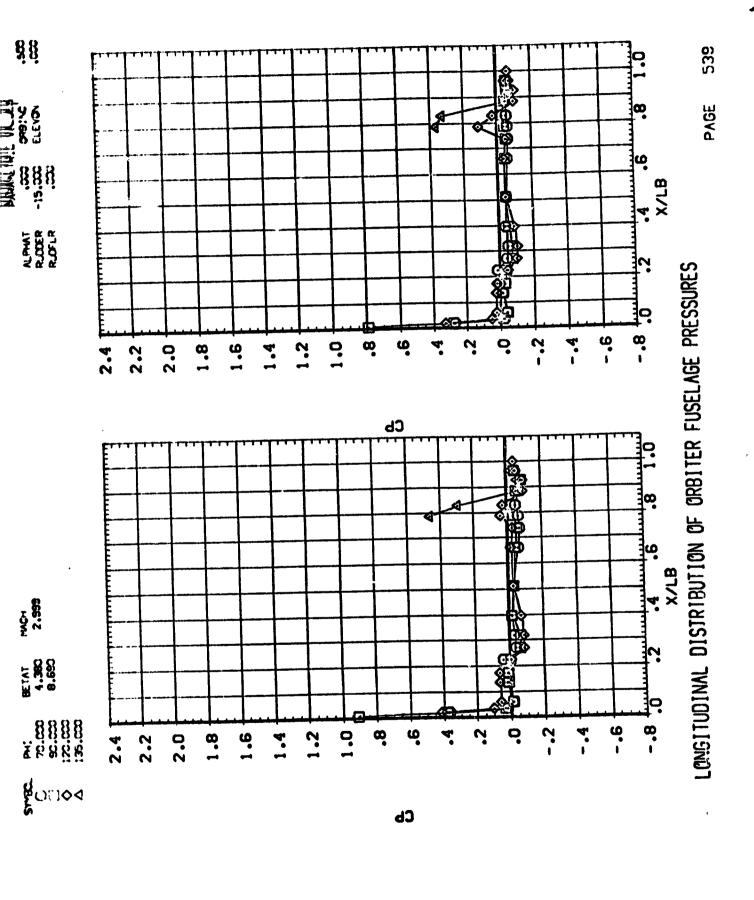
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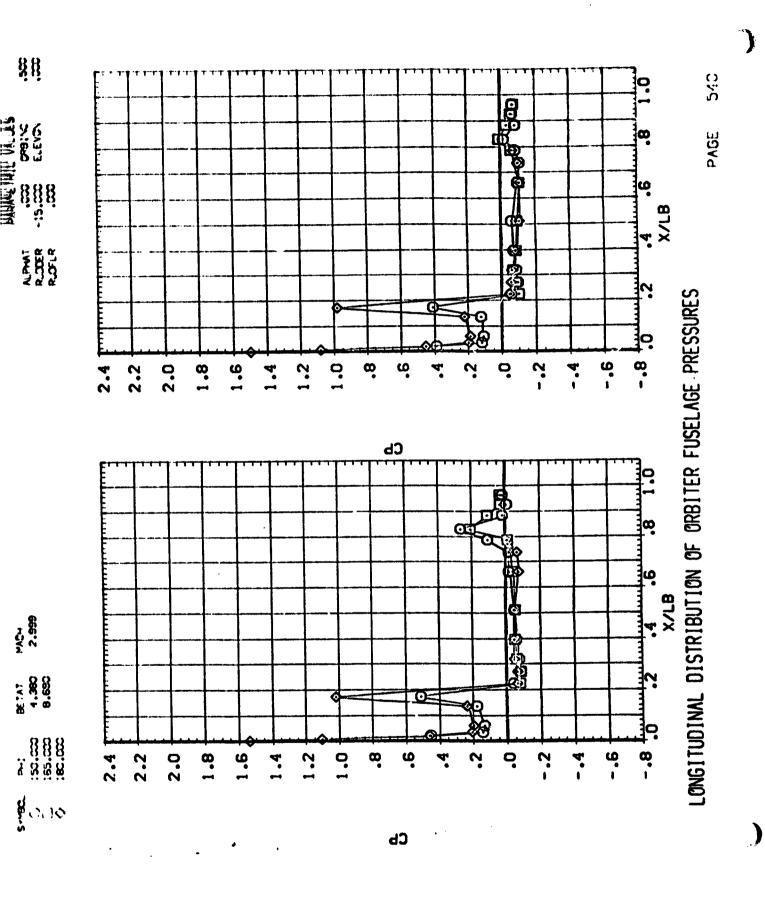
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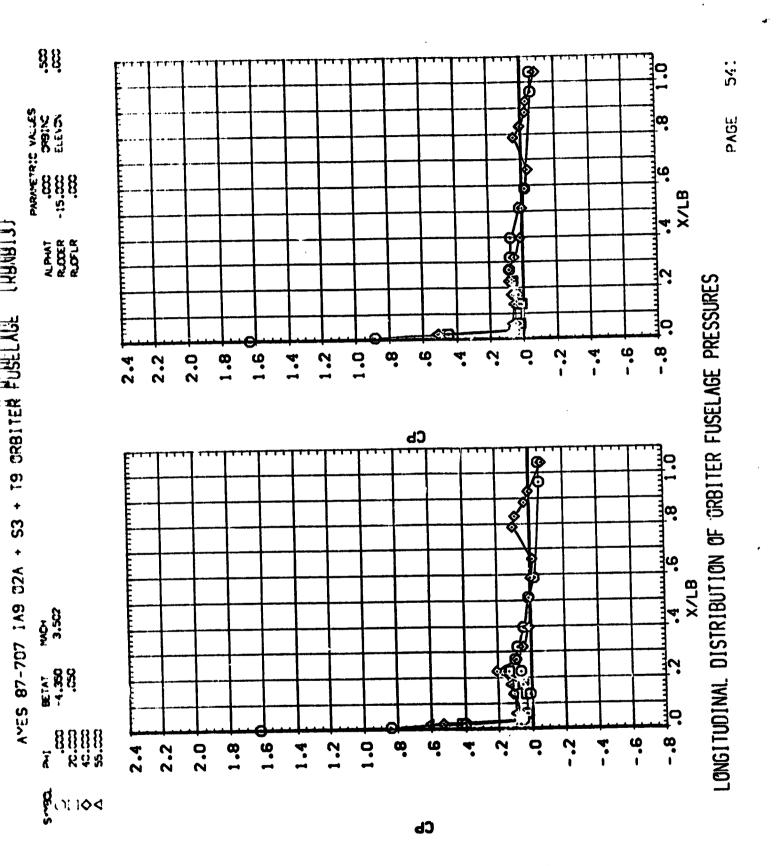


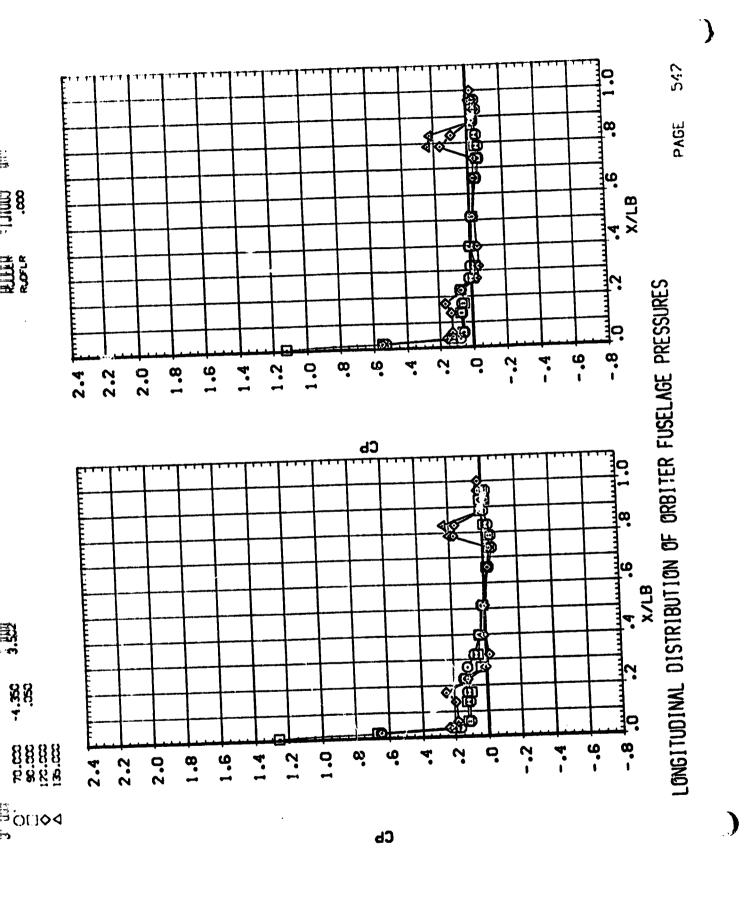


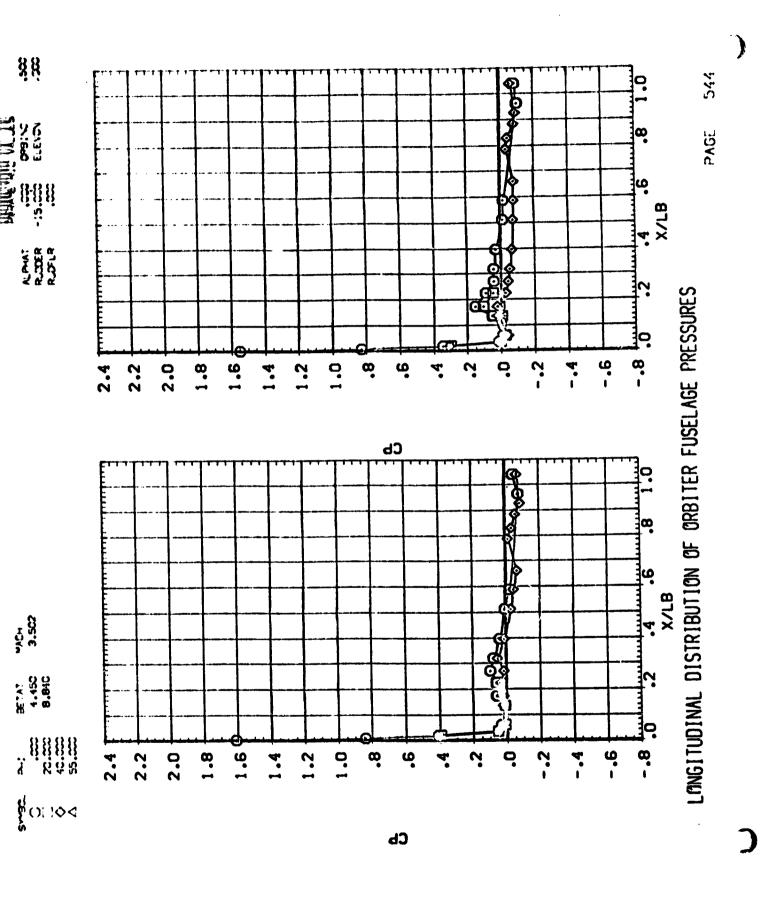












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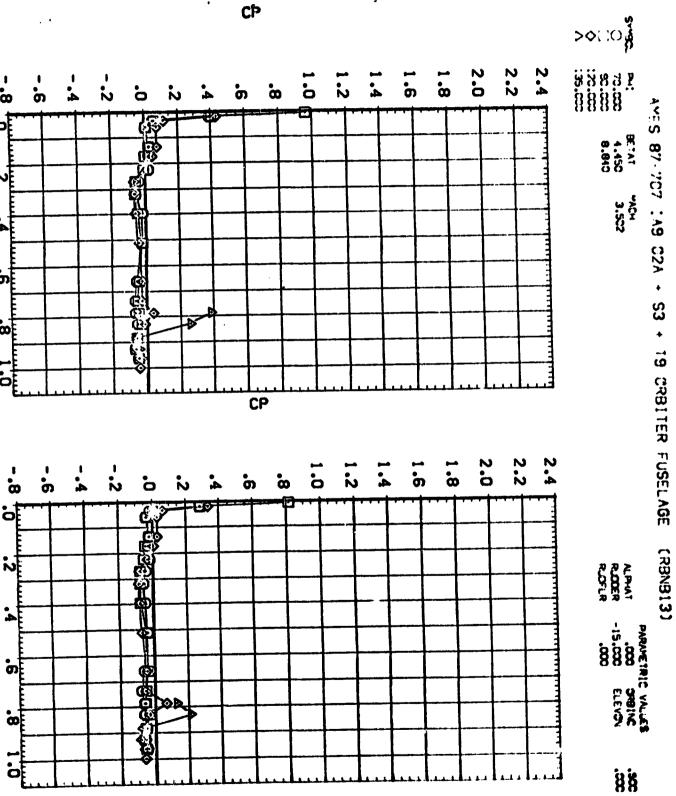
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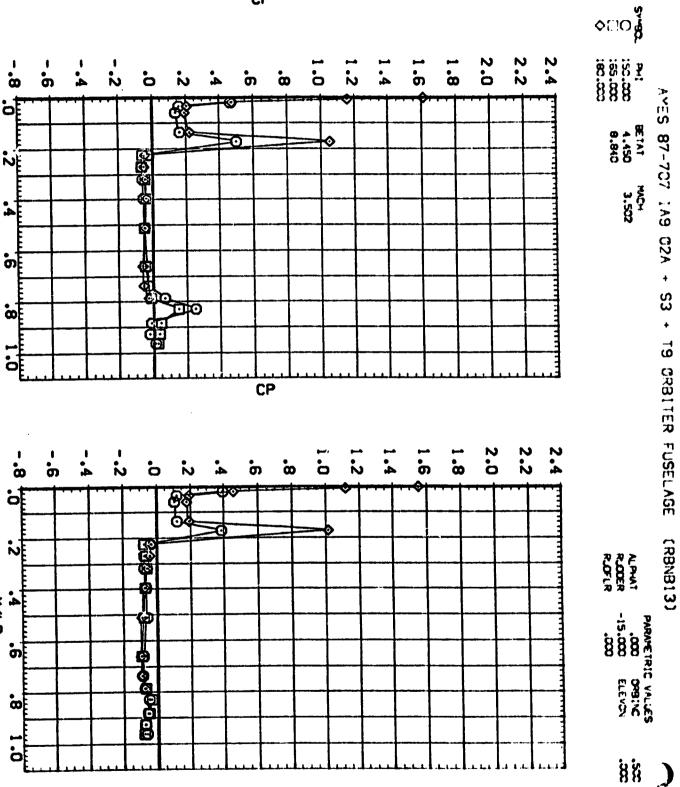
LONGITUDINAL DISTRIBUTION OF ORBITER FUSELAGE PRESSURES

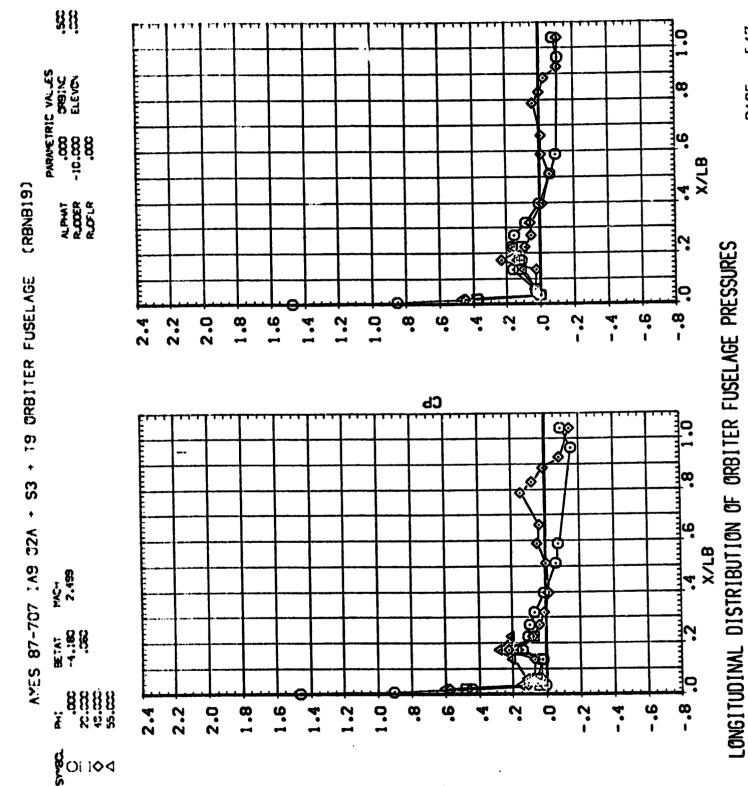
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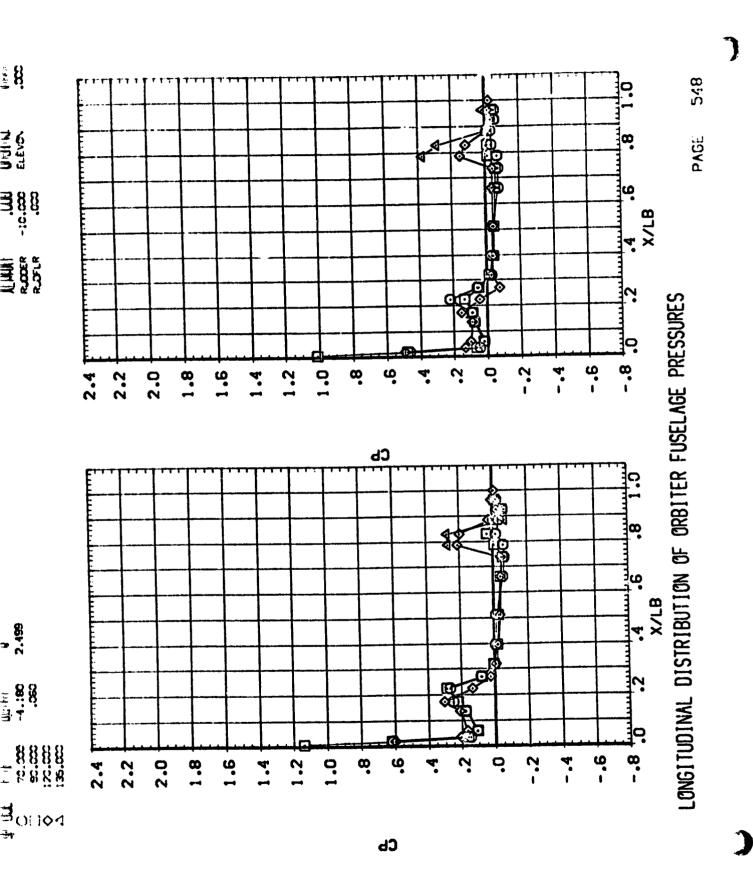
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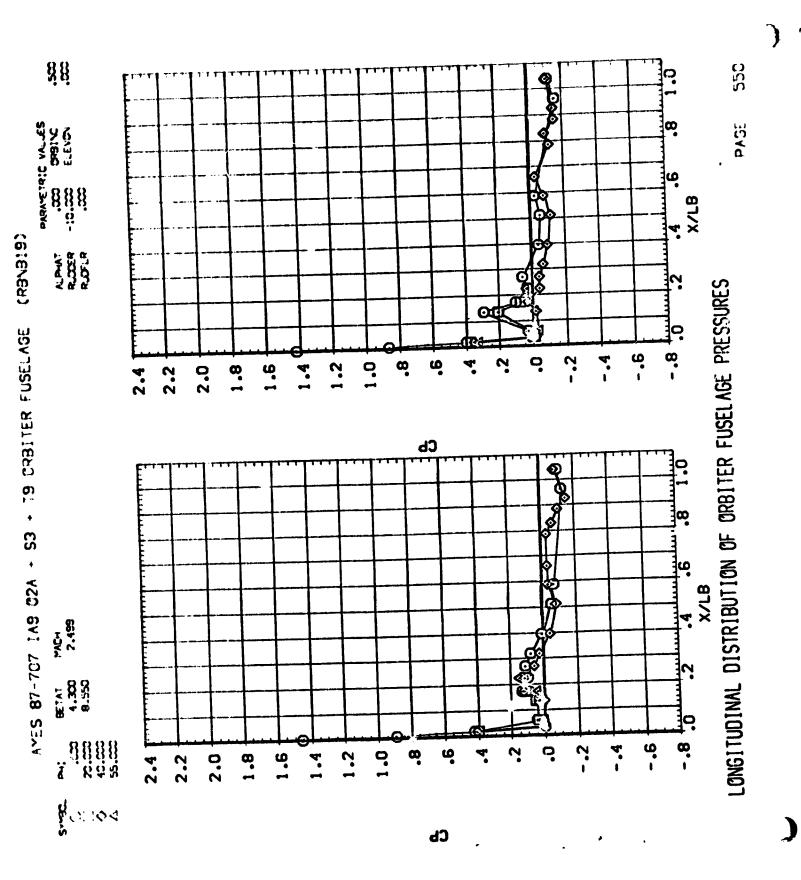


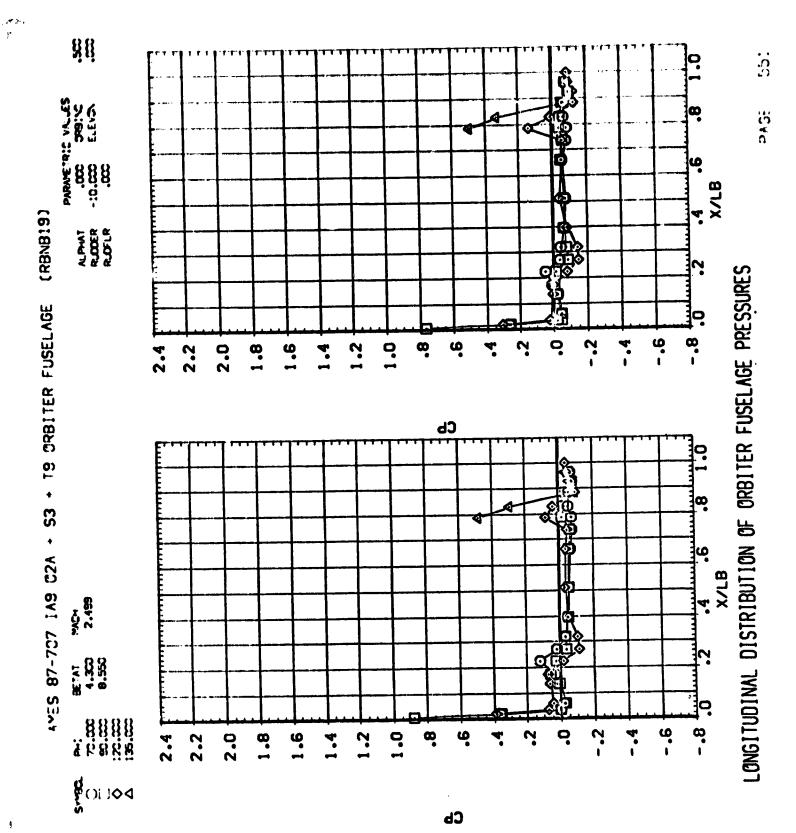


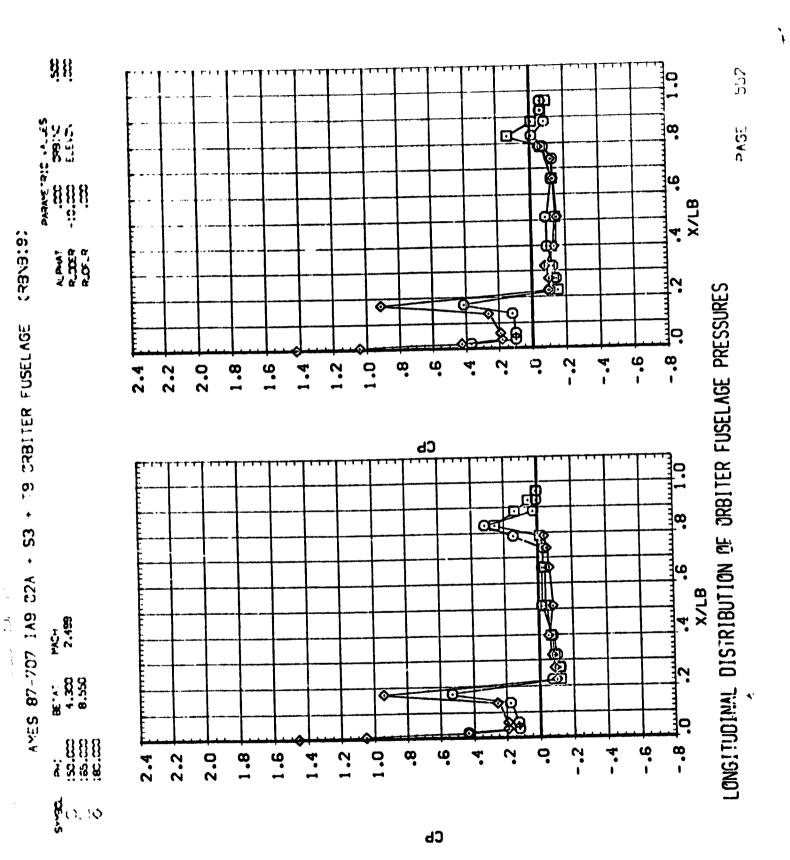


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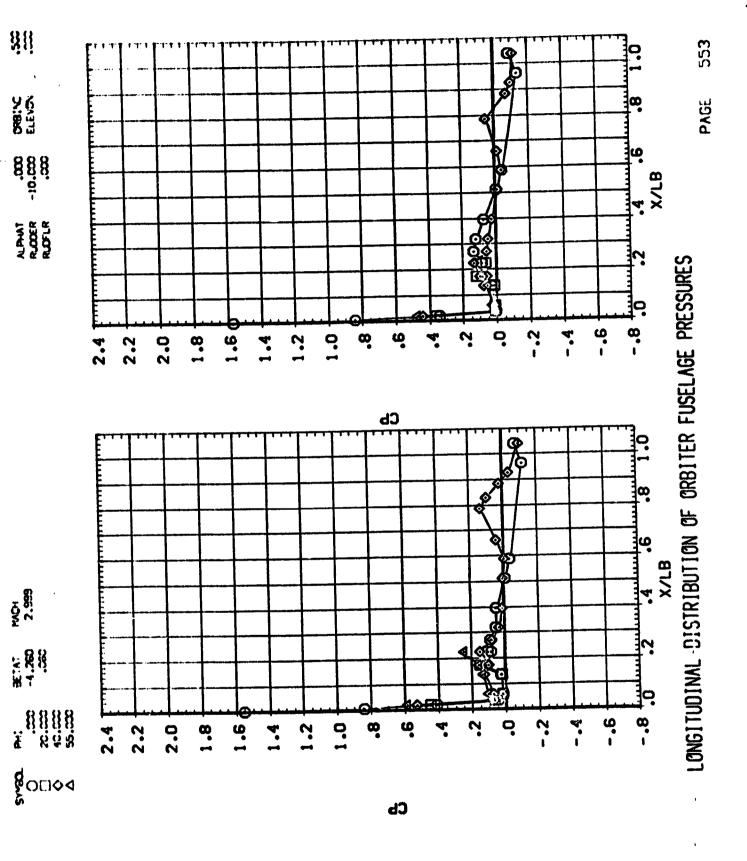
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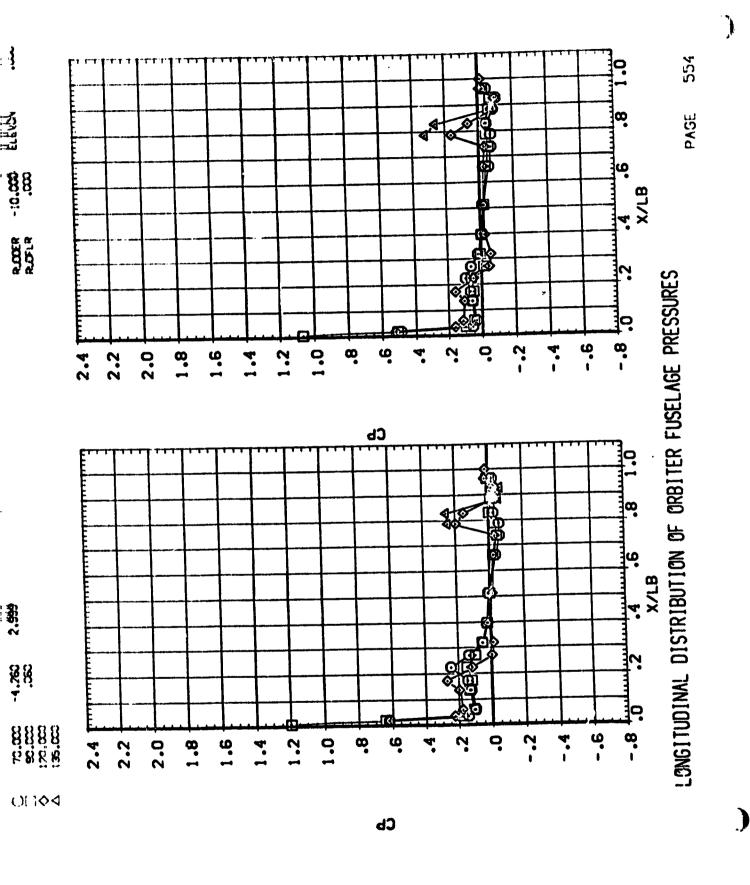


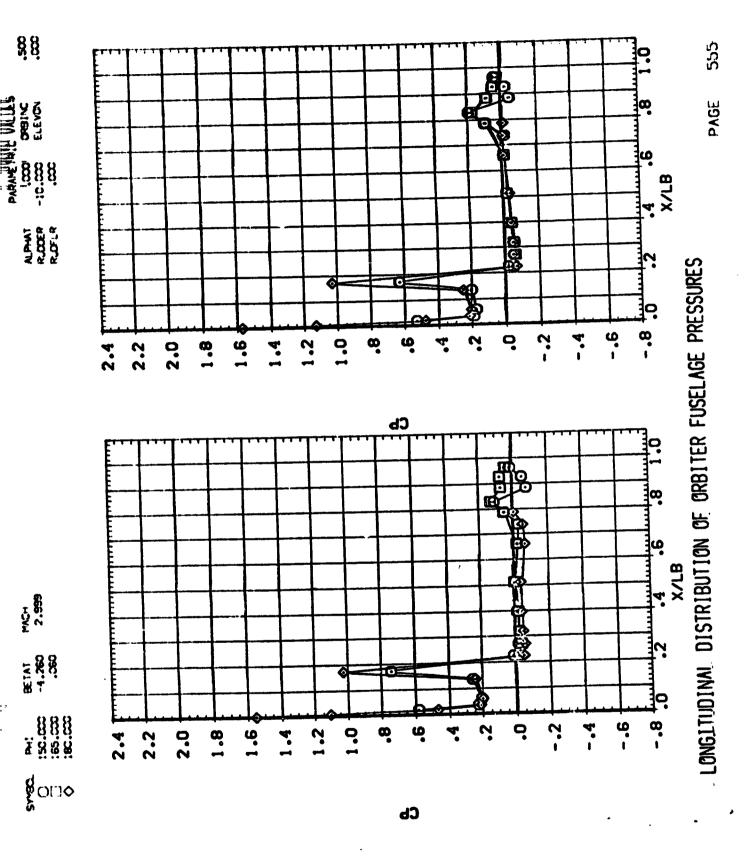




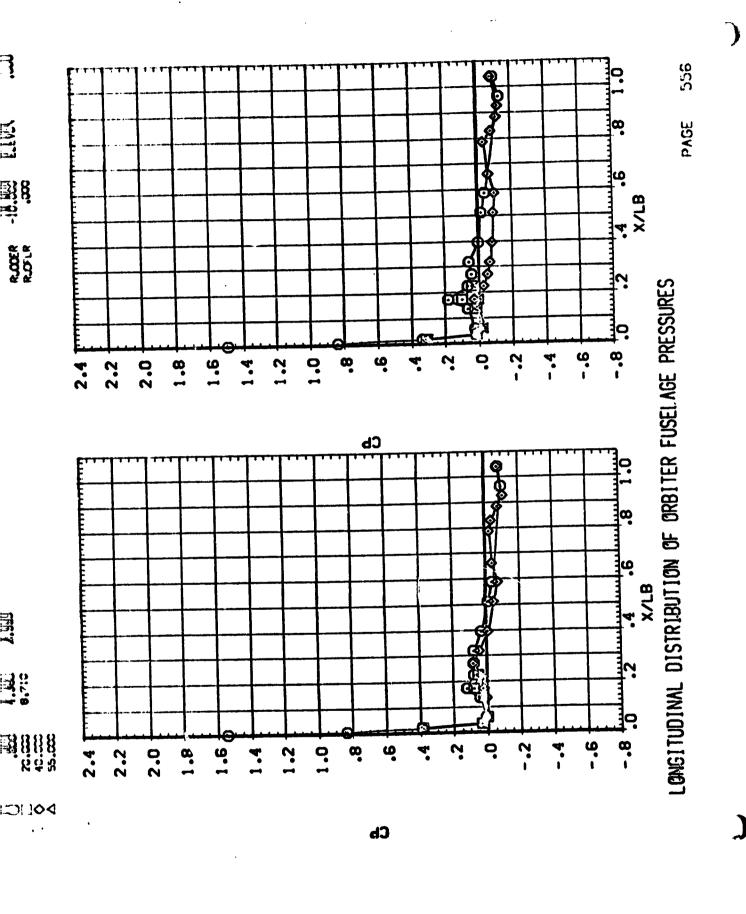
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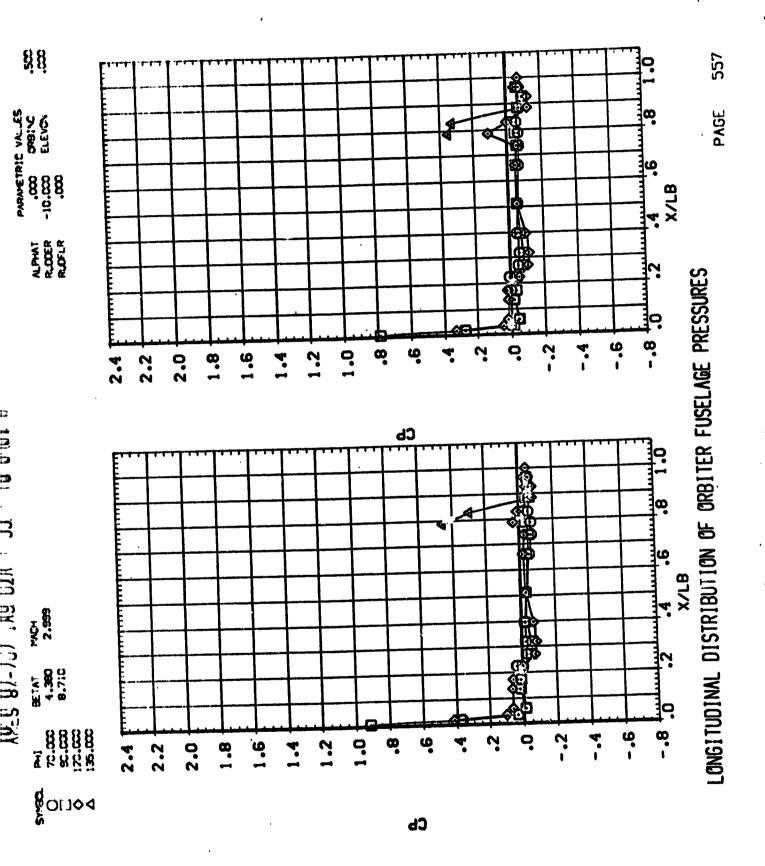


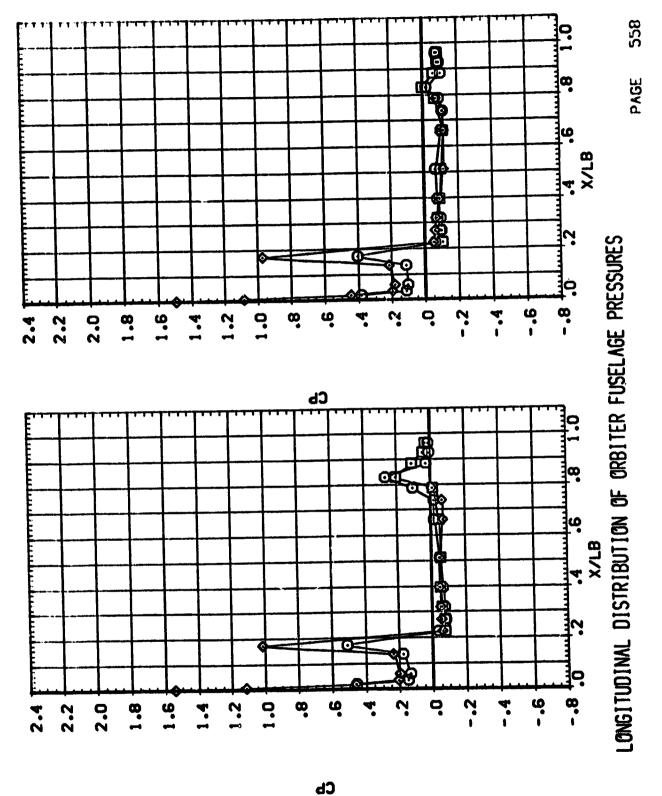




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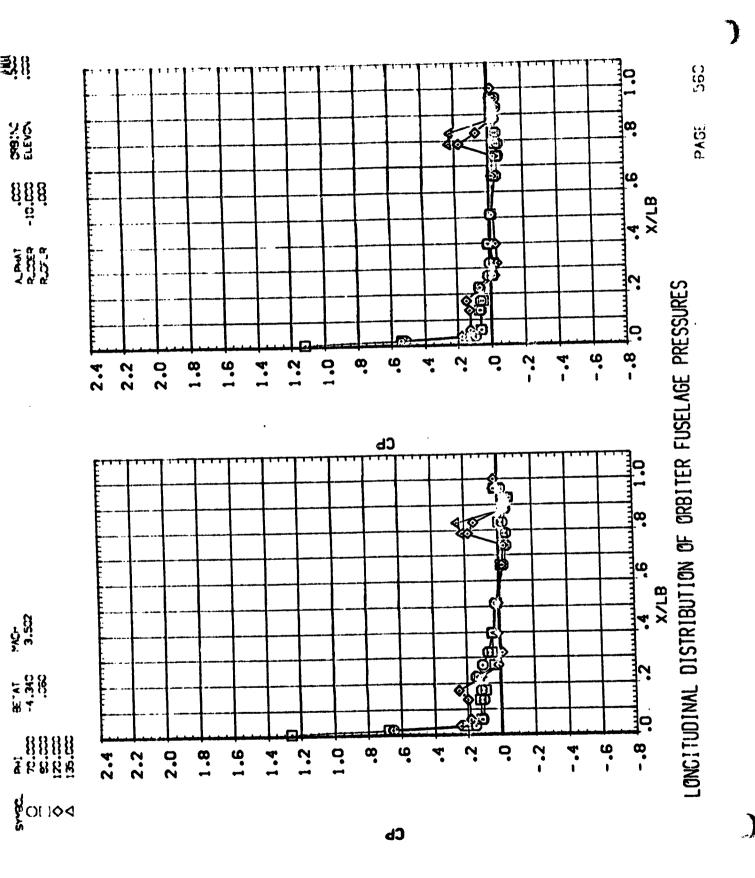
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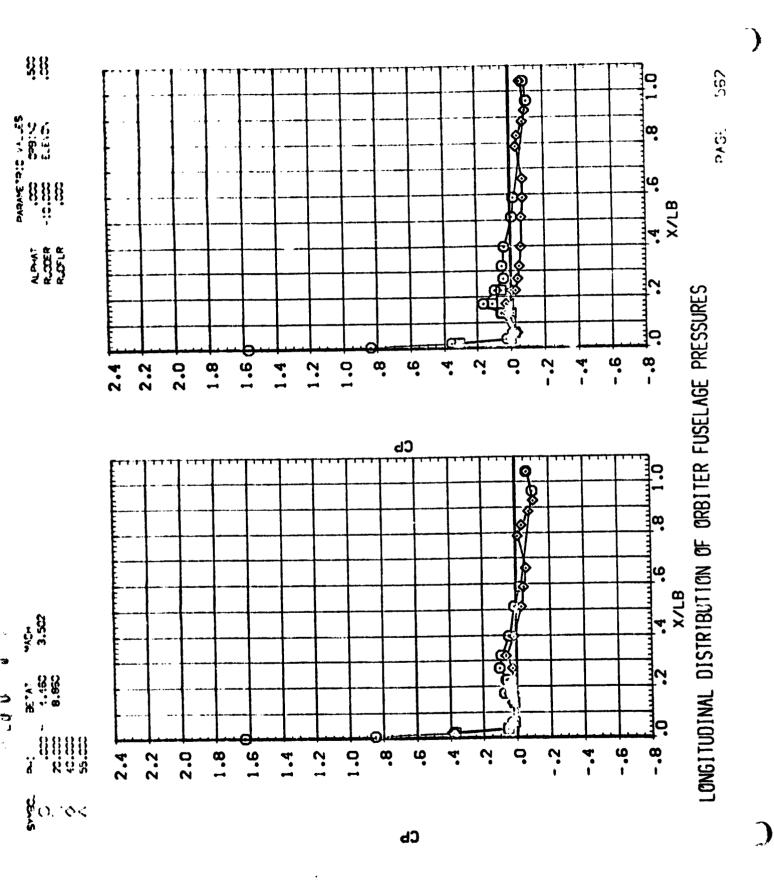
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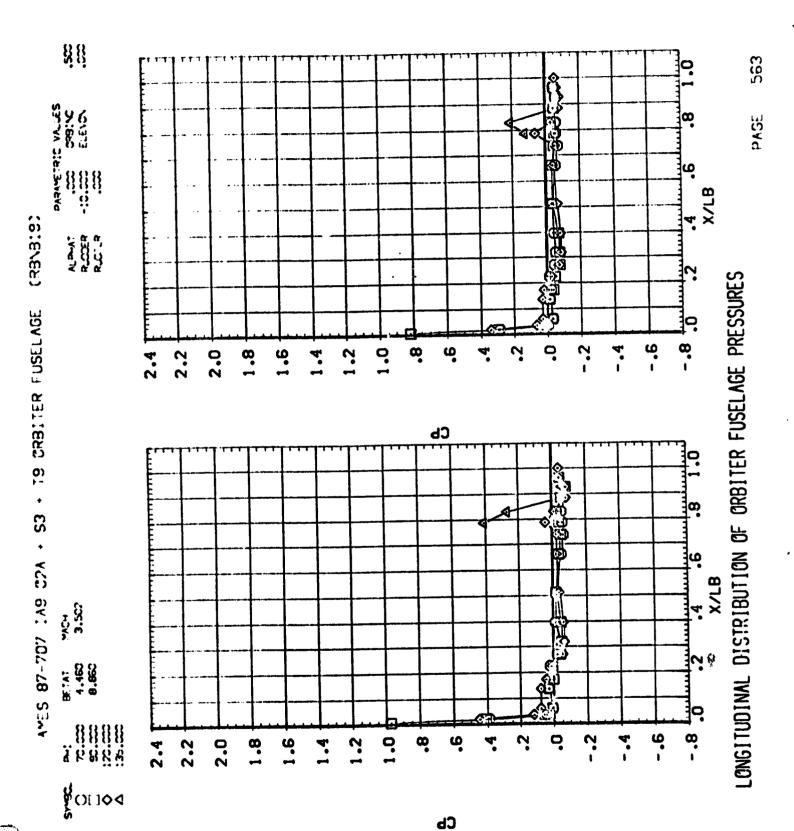
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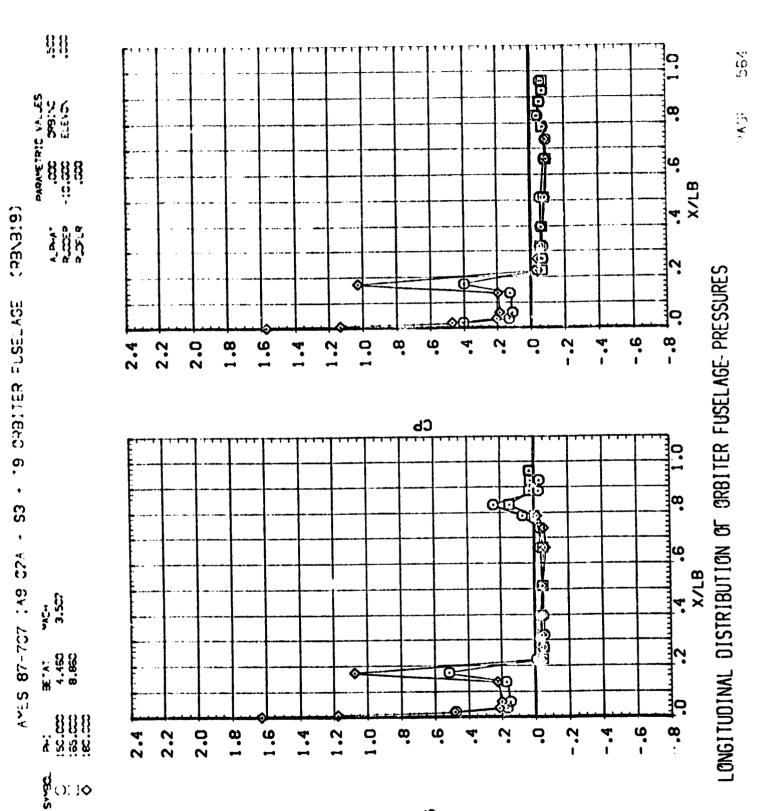
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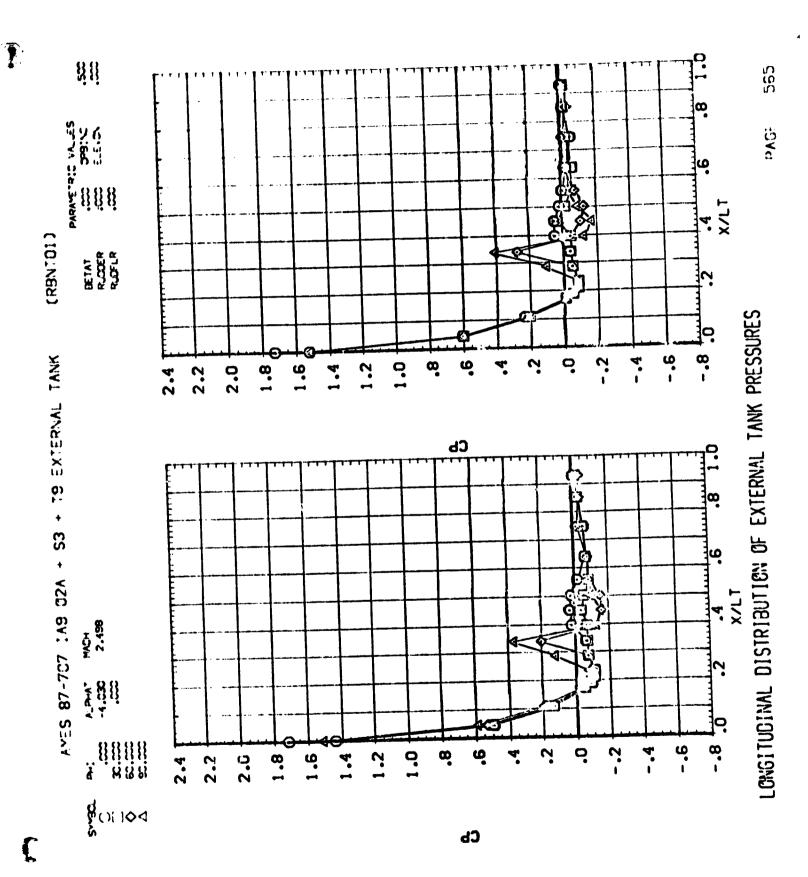


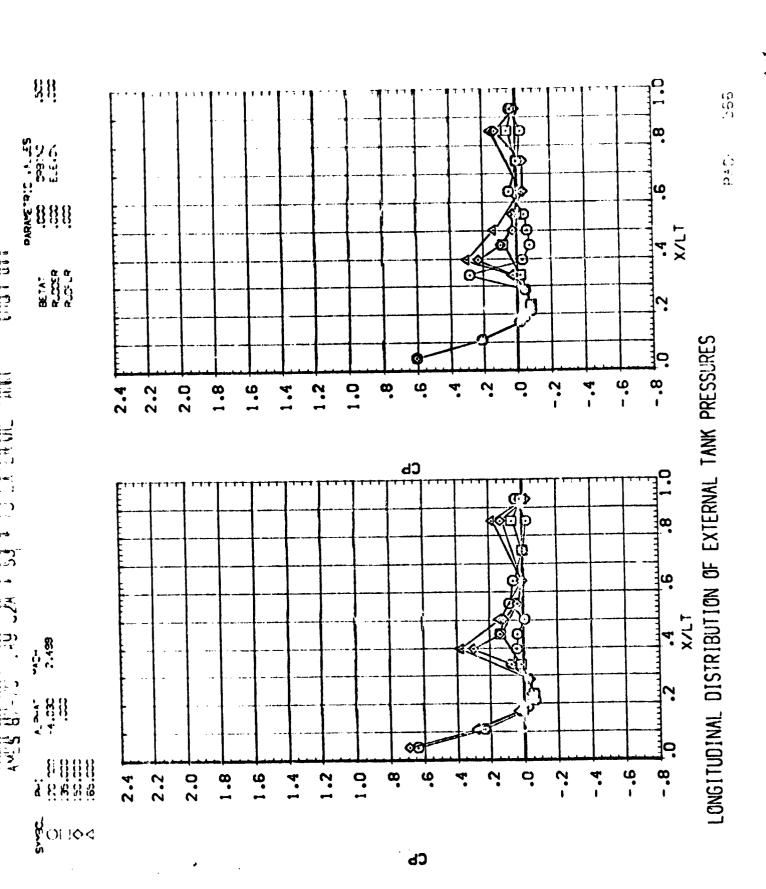


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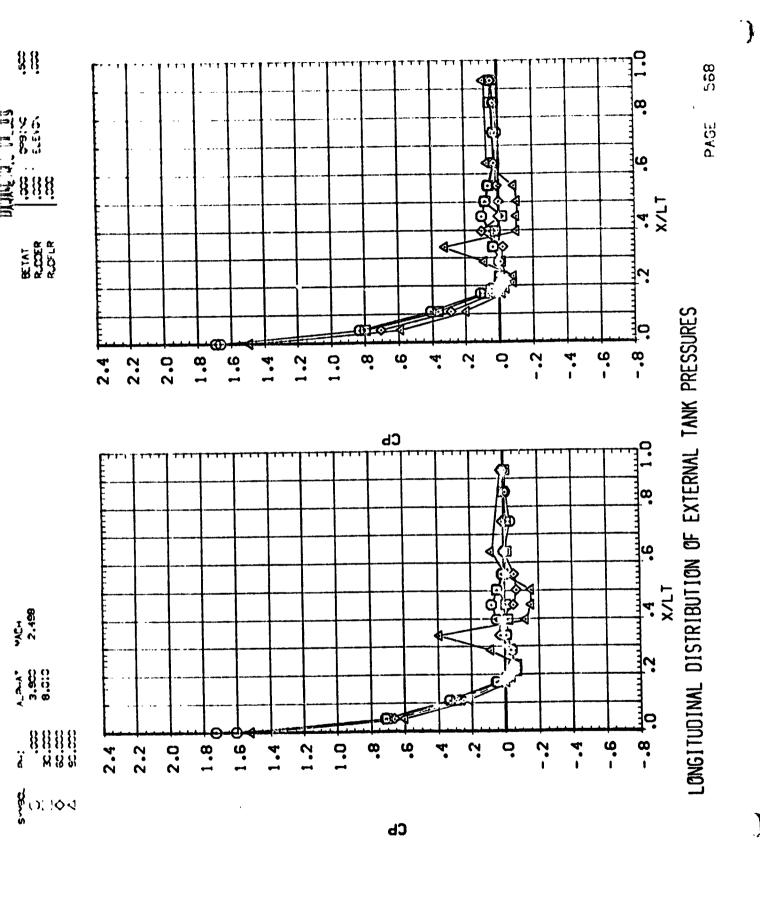


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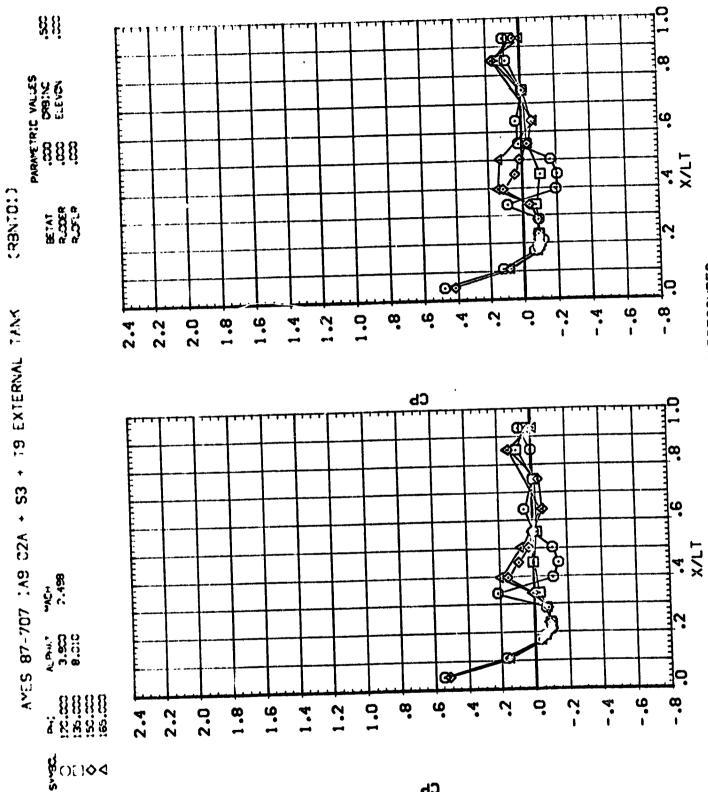


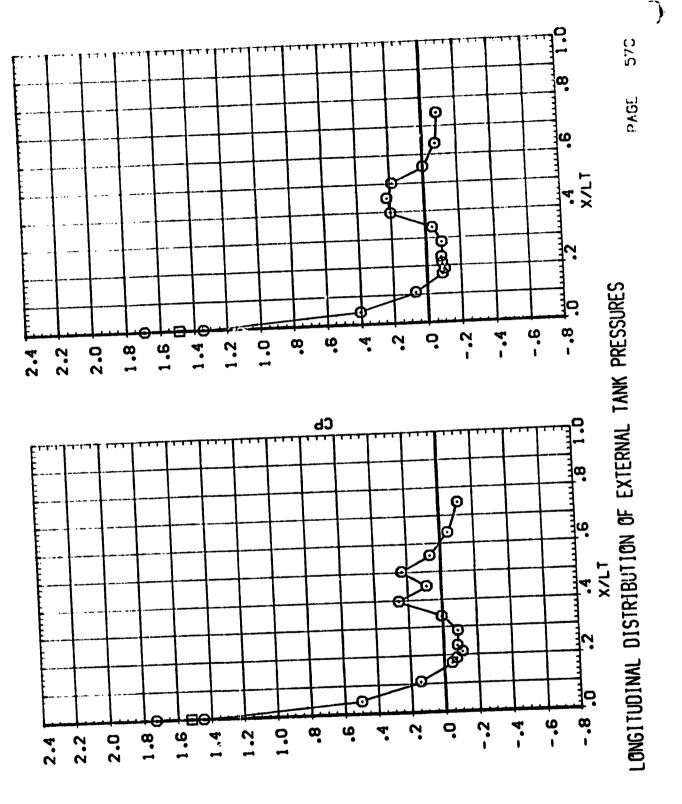


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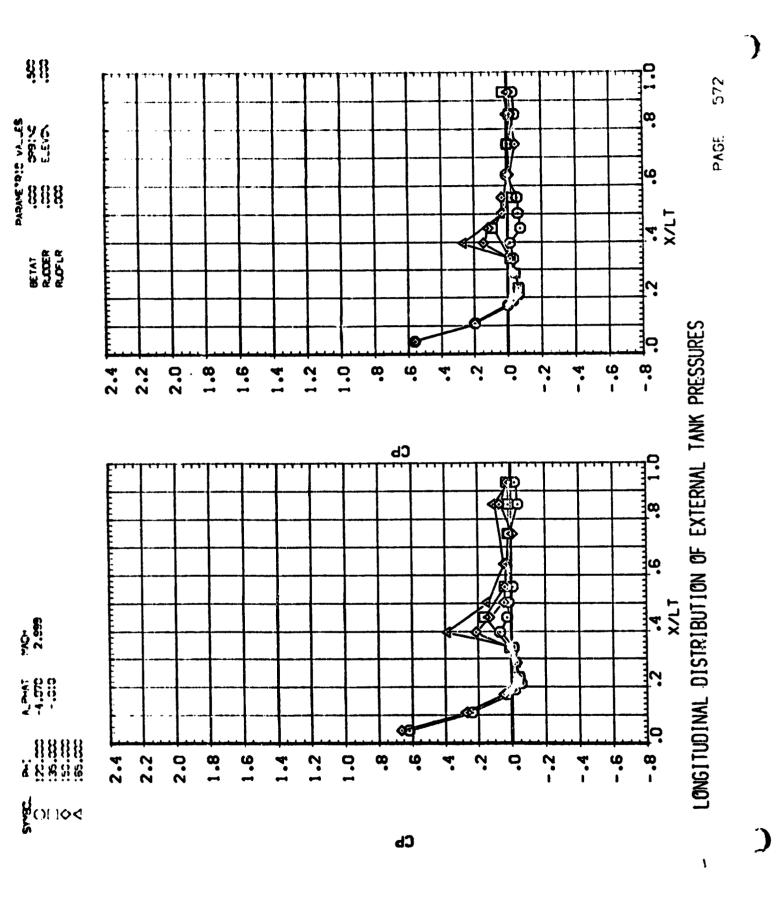


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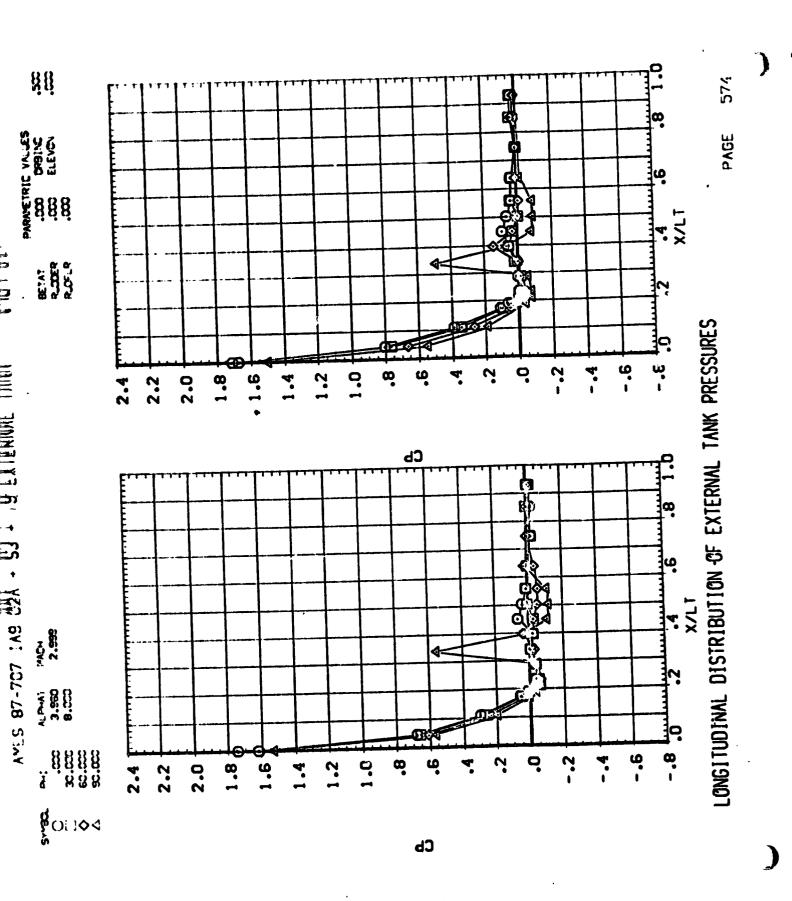
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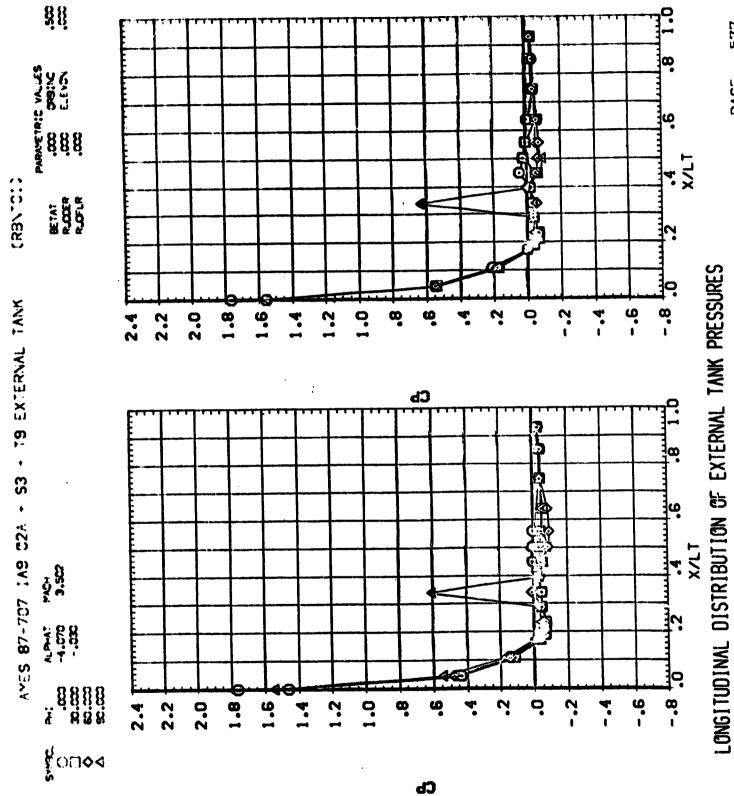
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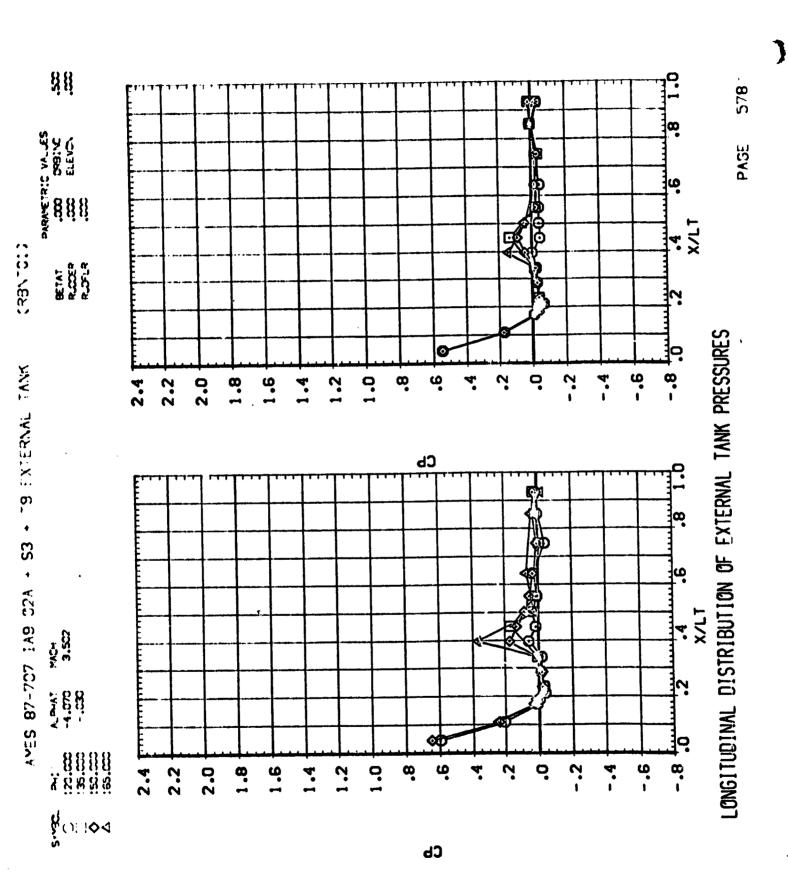
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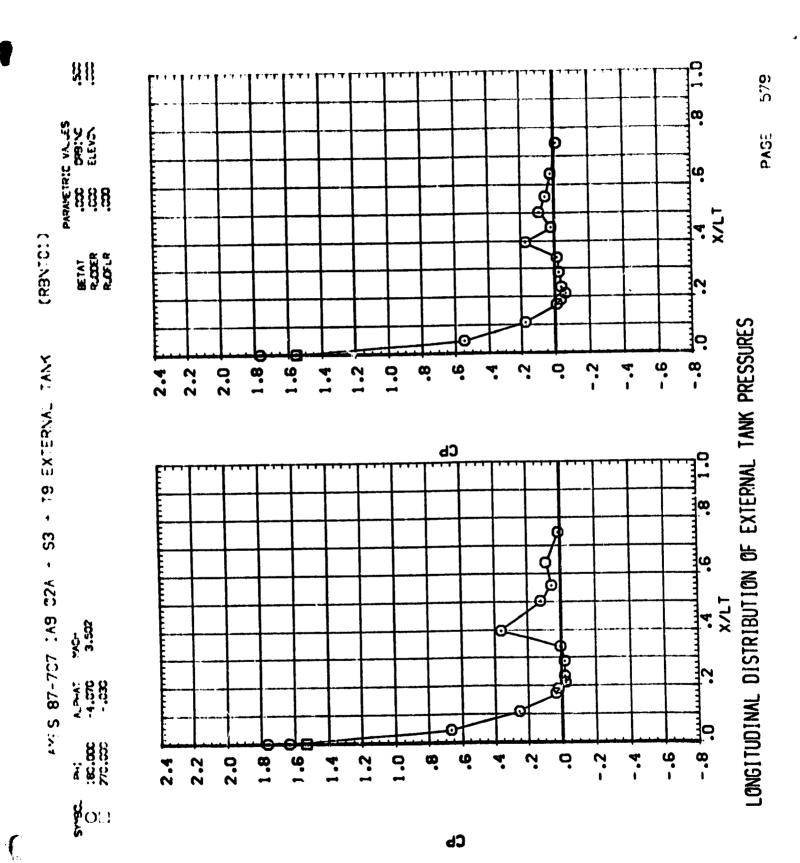
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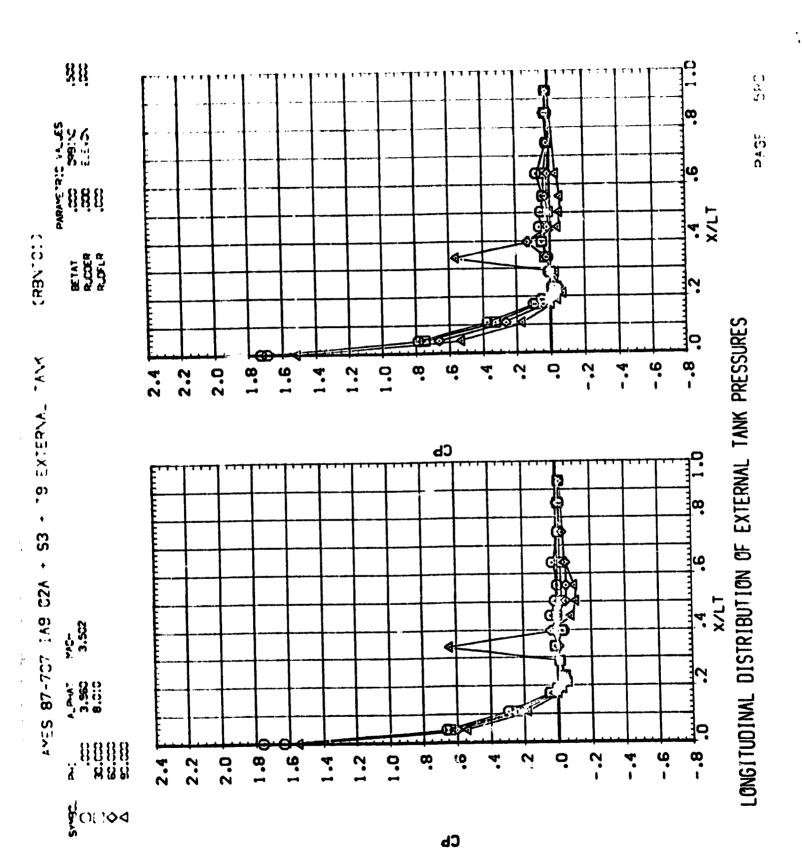


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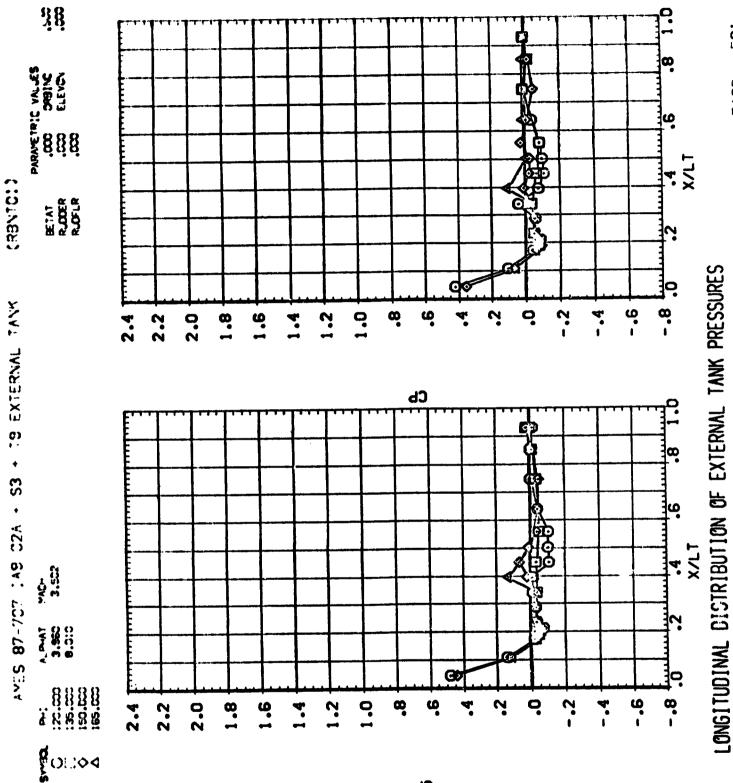




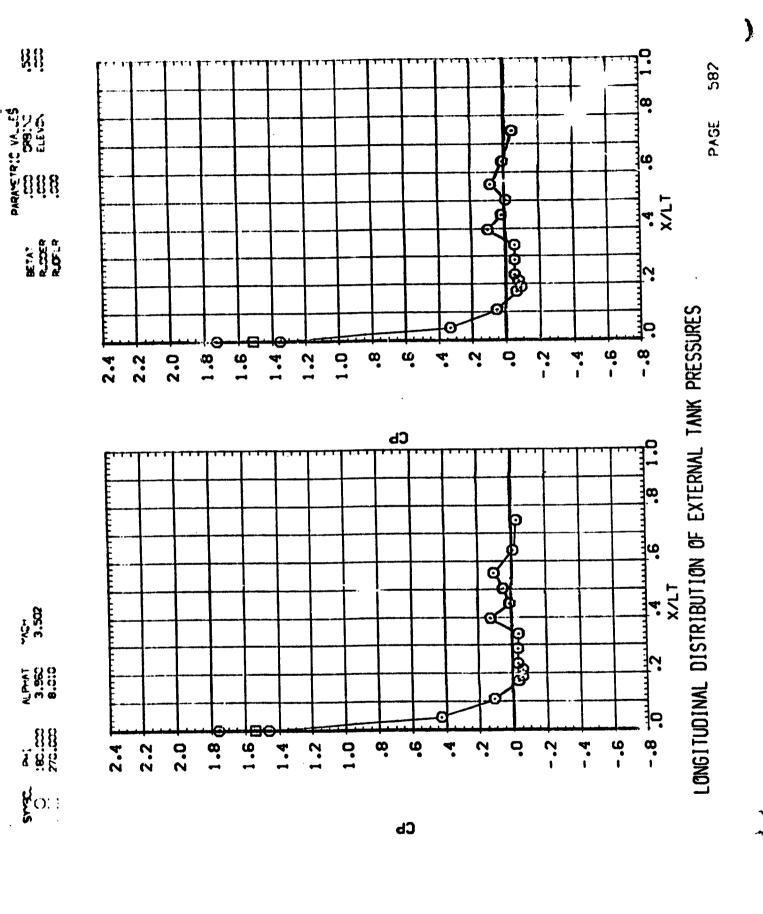




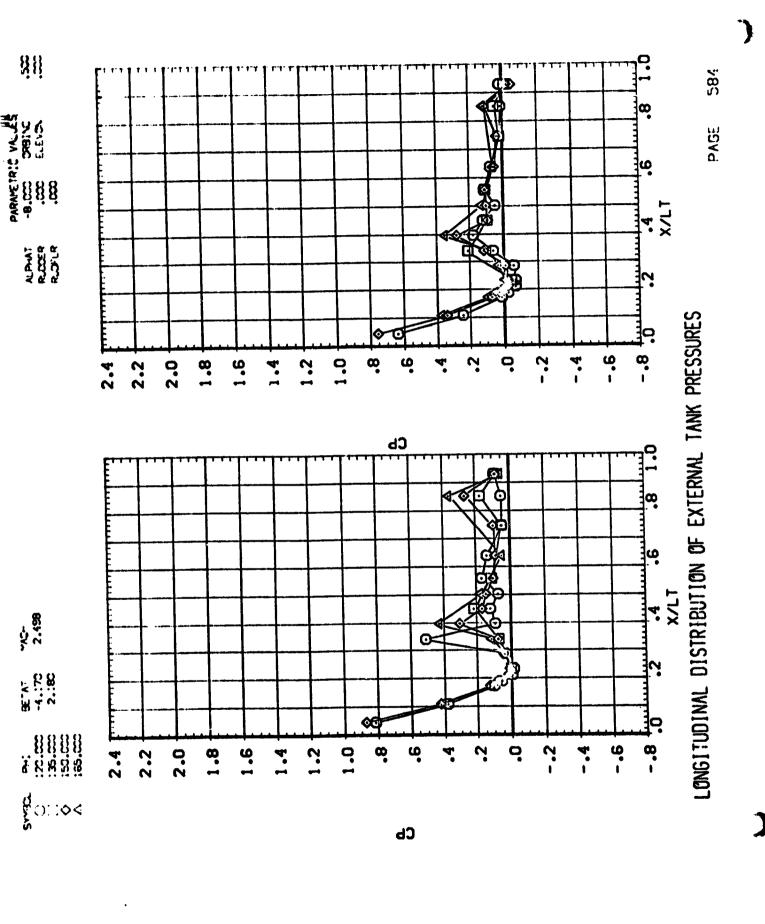
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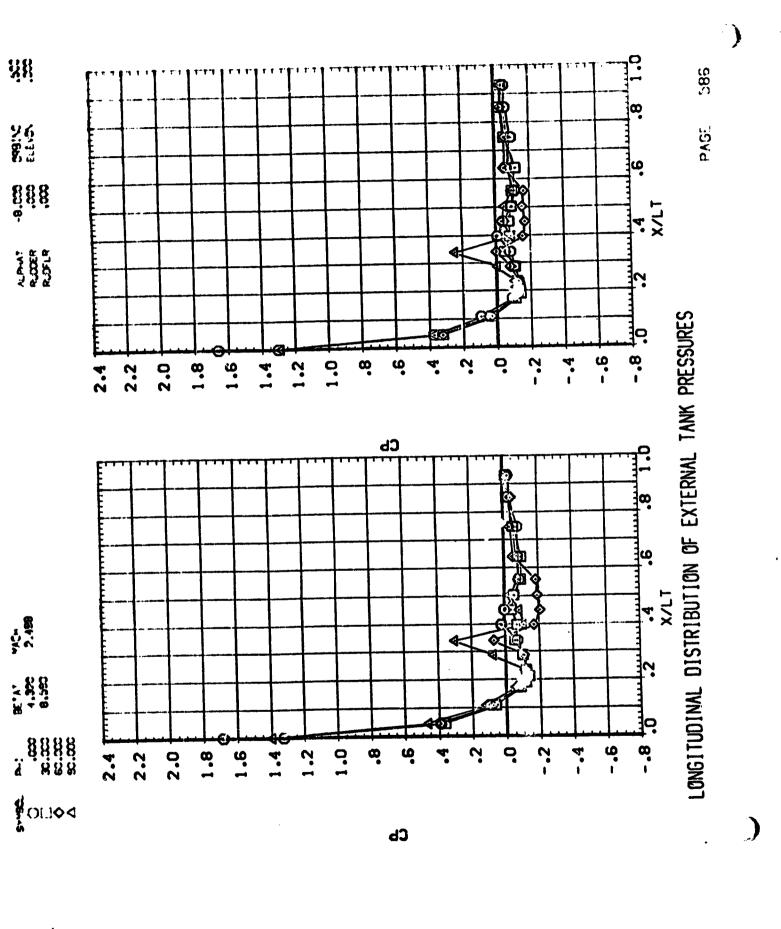
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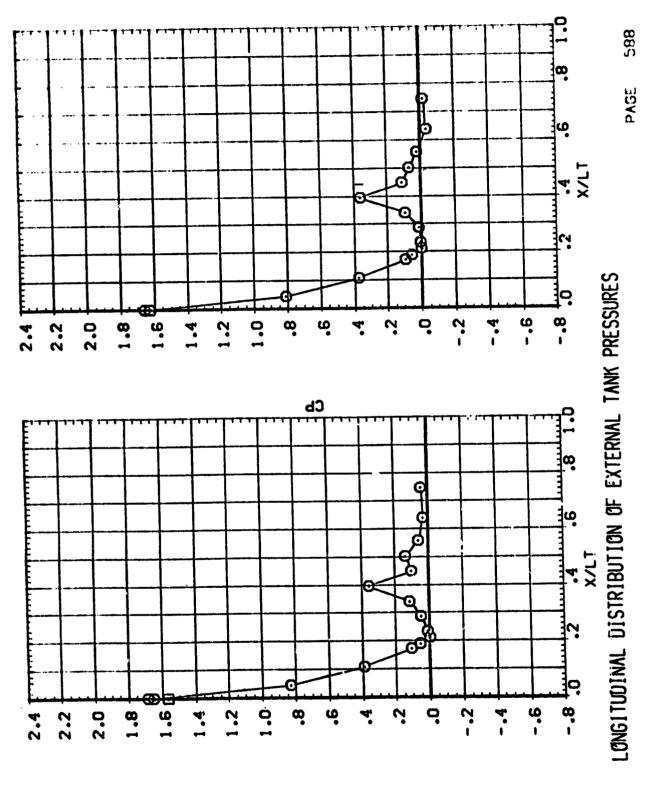
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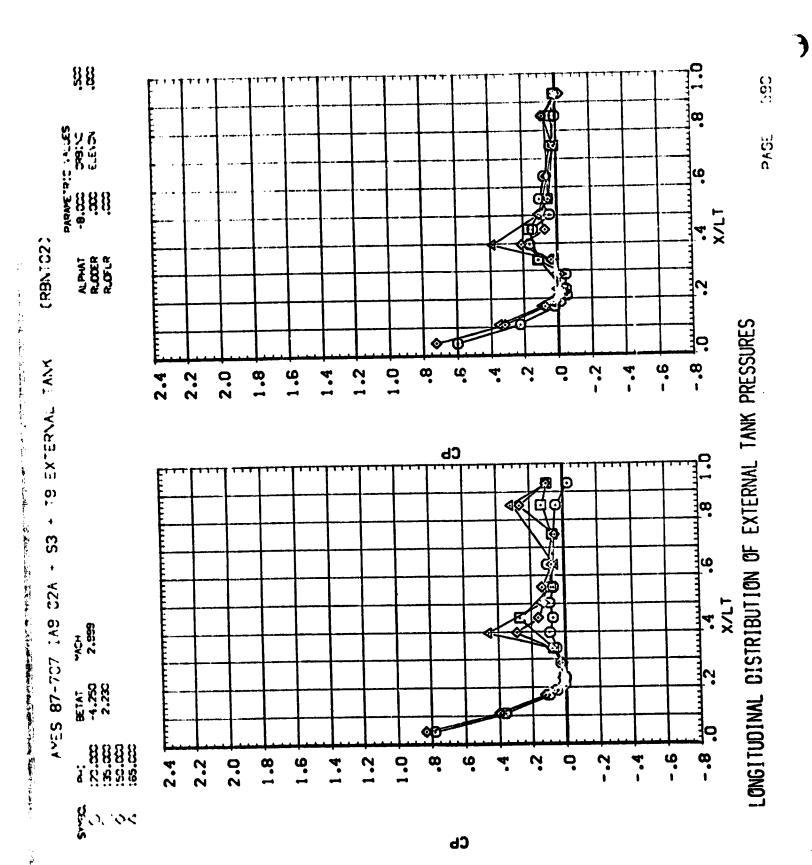
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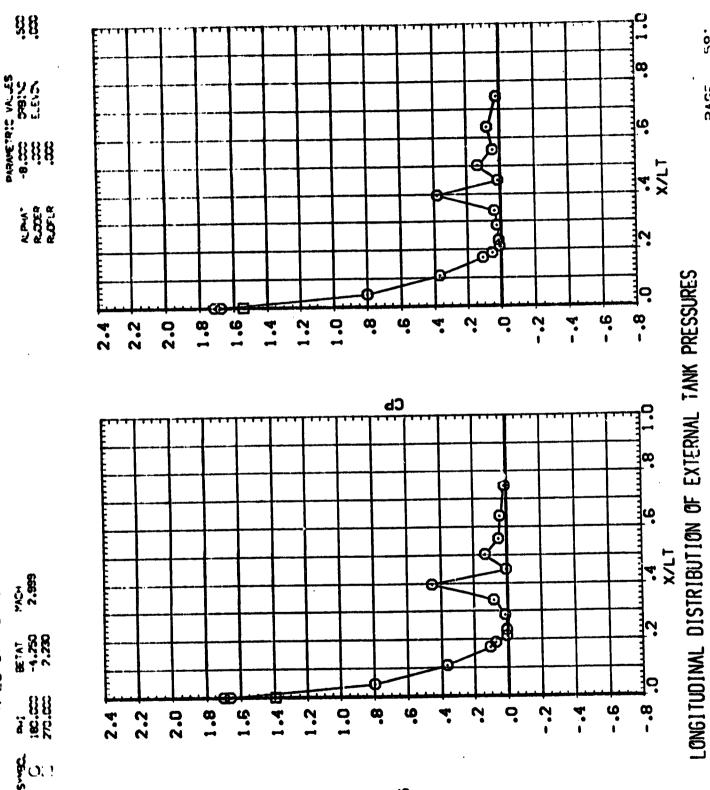
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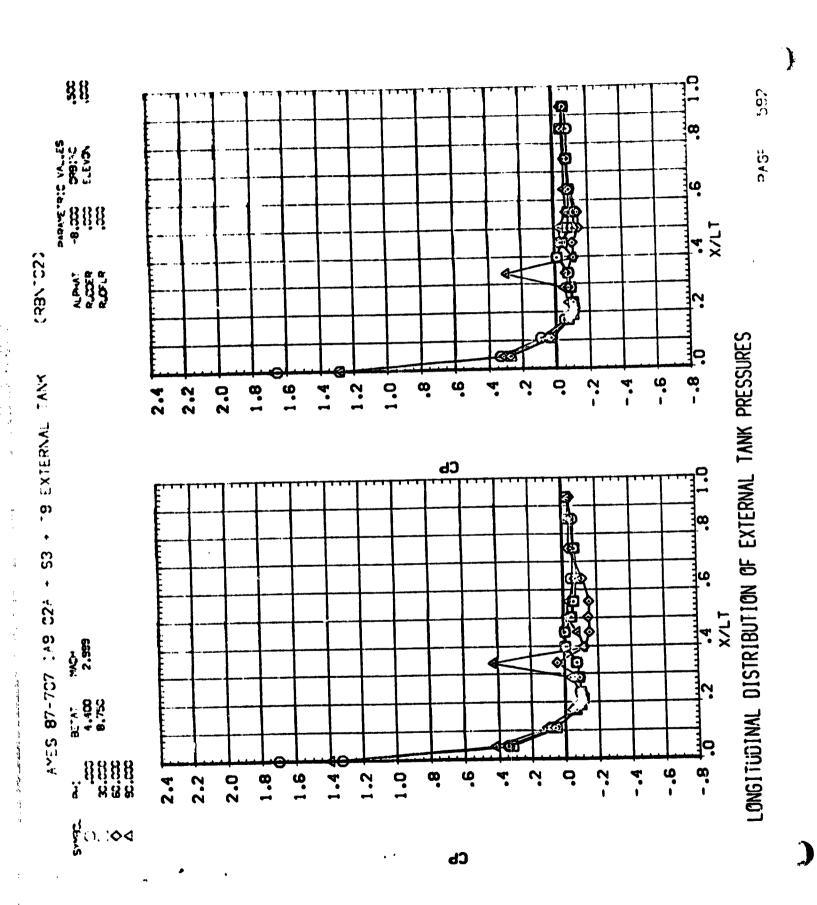


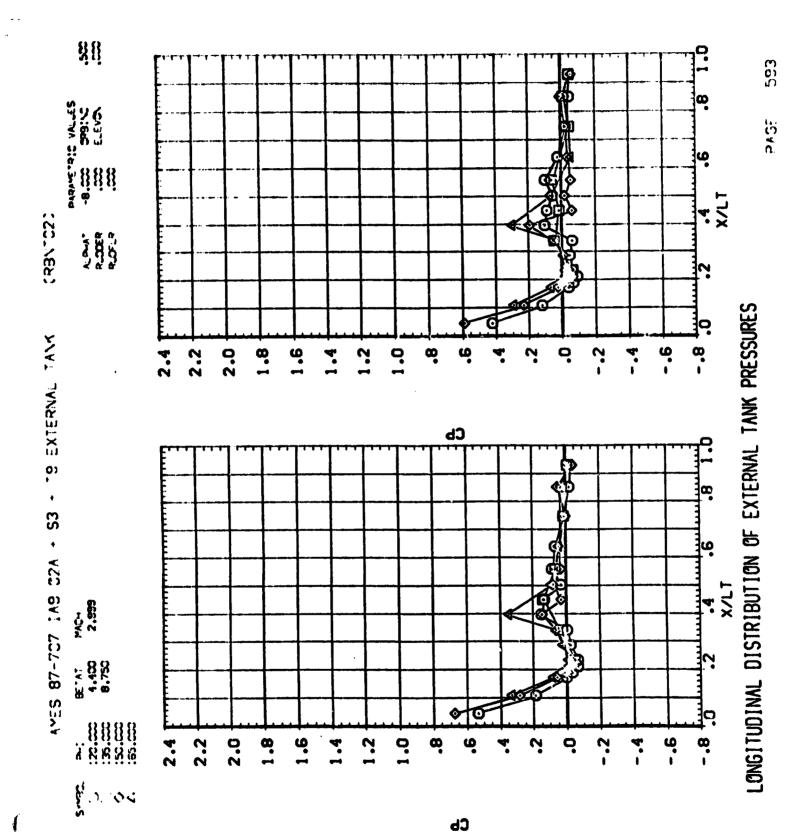
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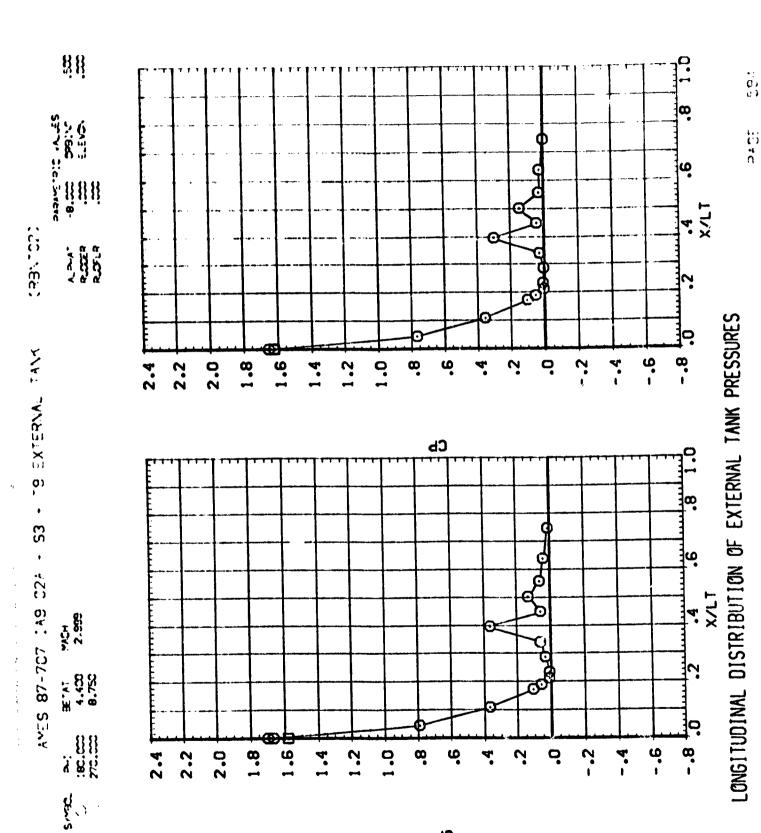
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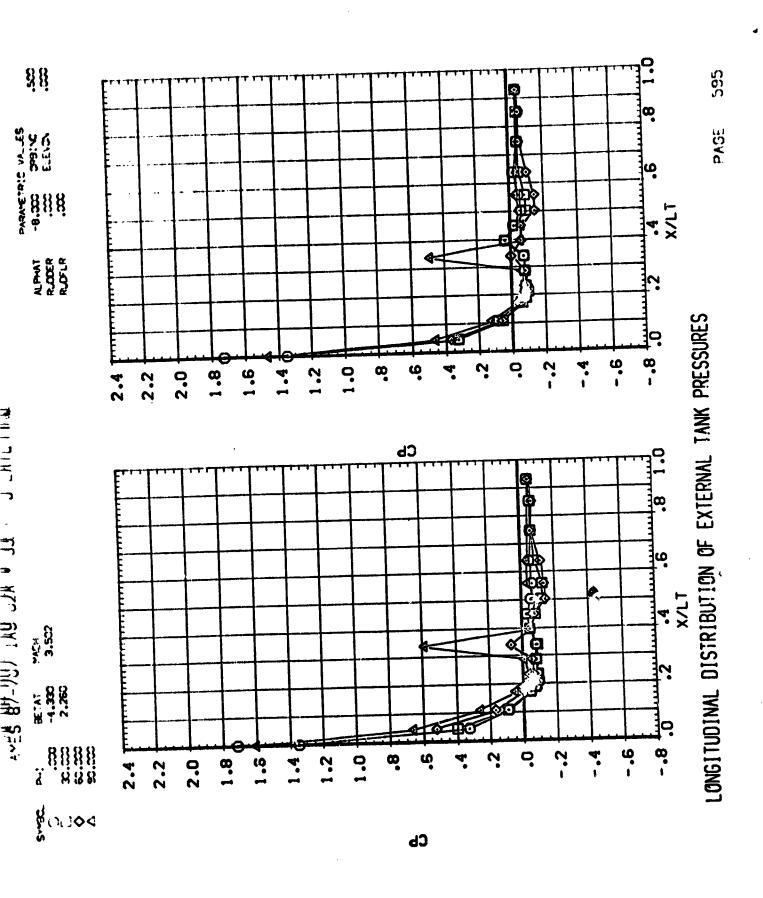
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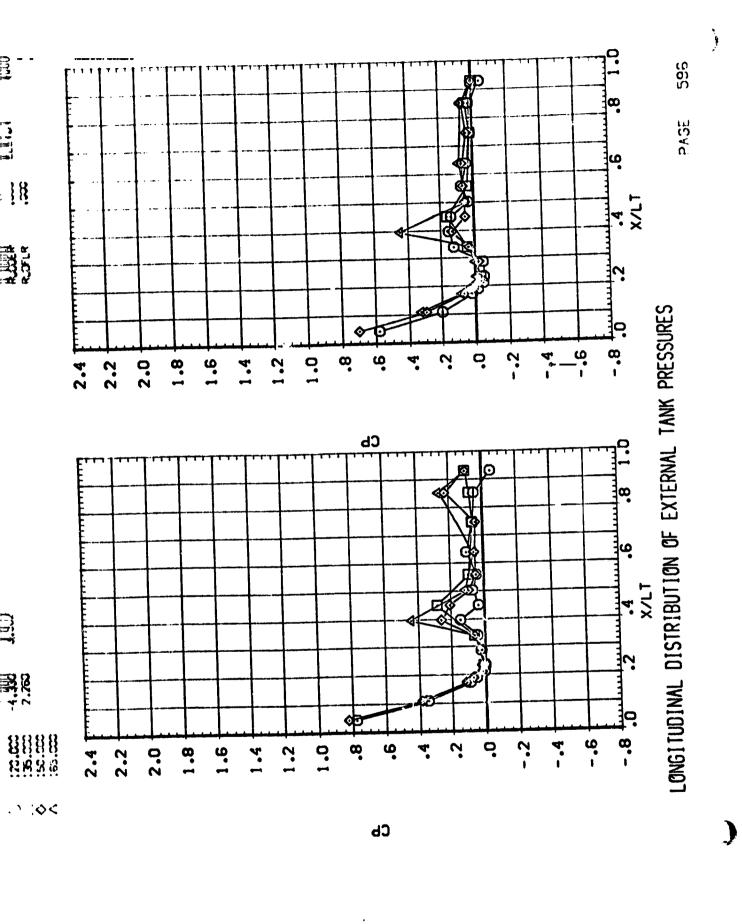


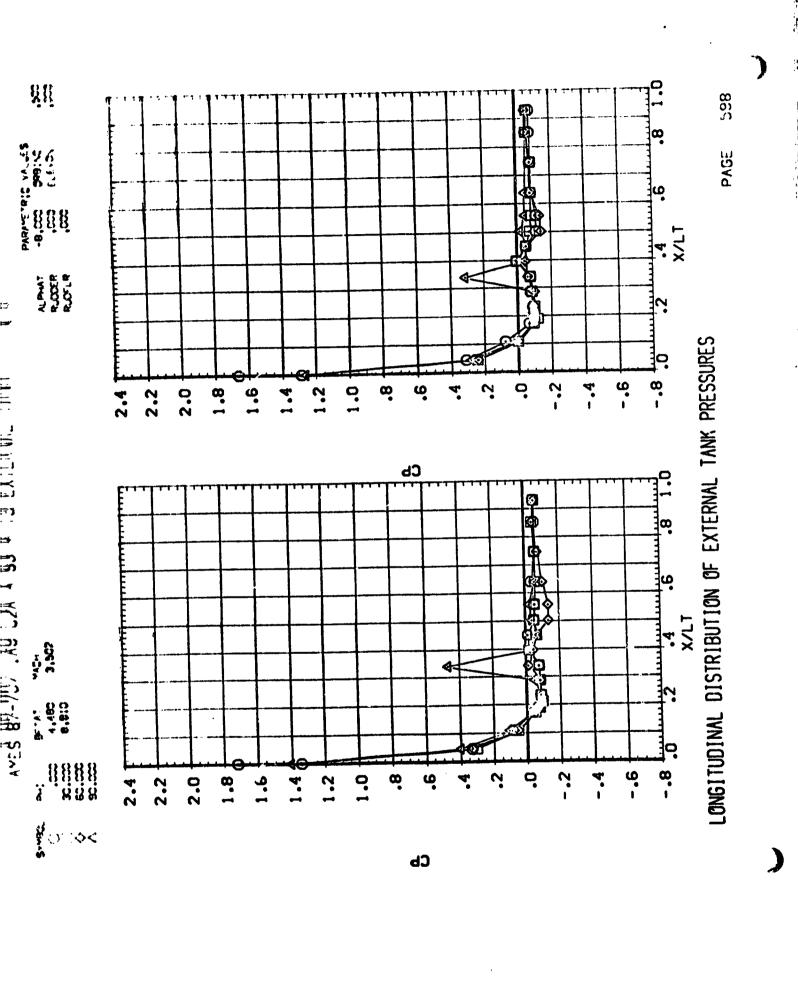


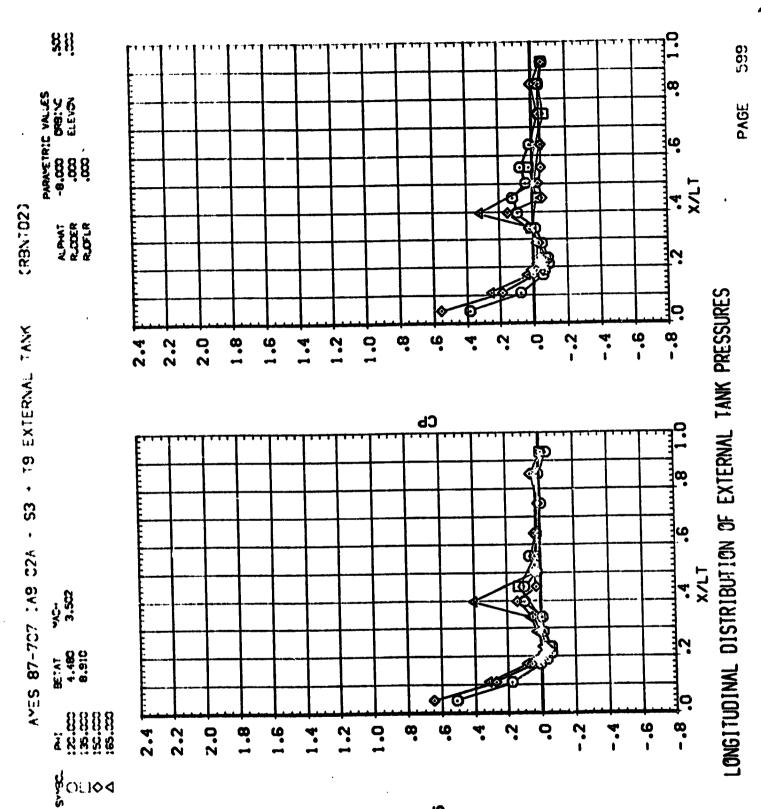


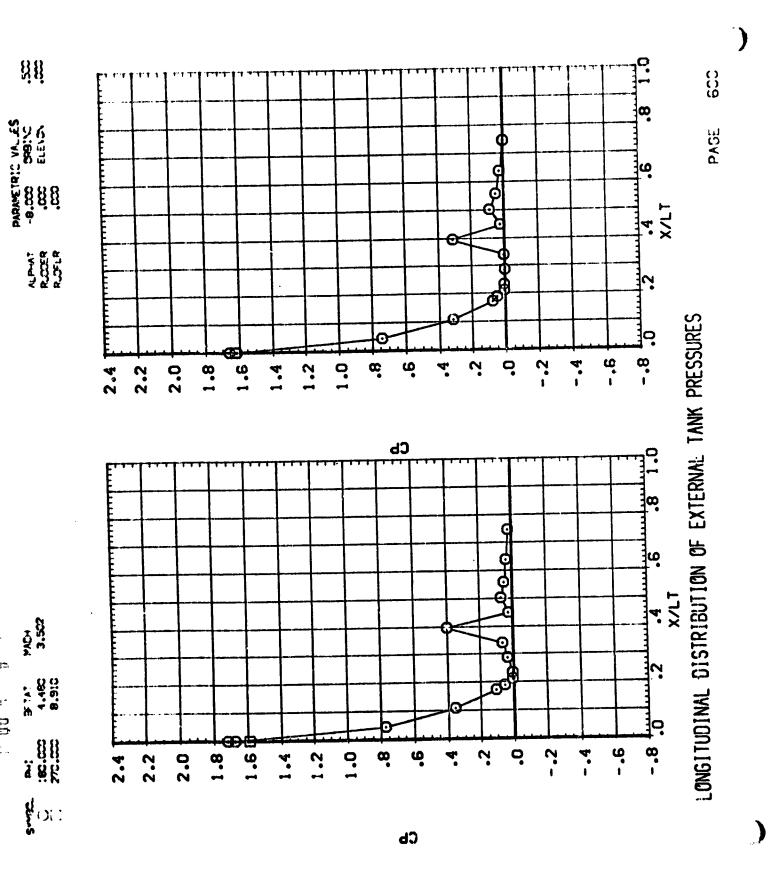


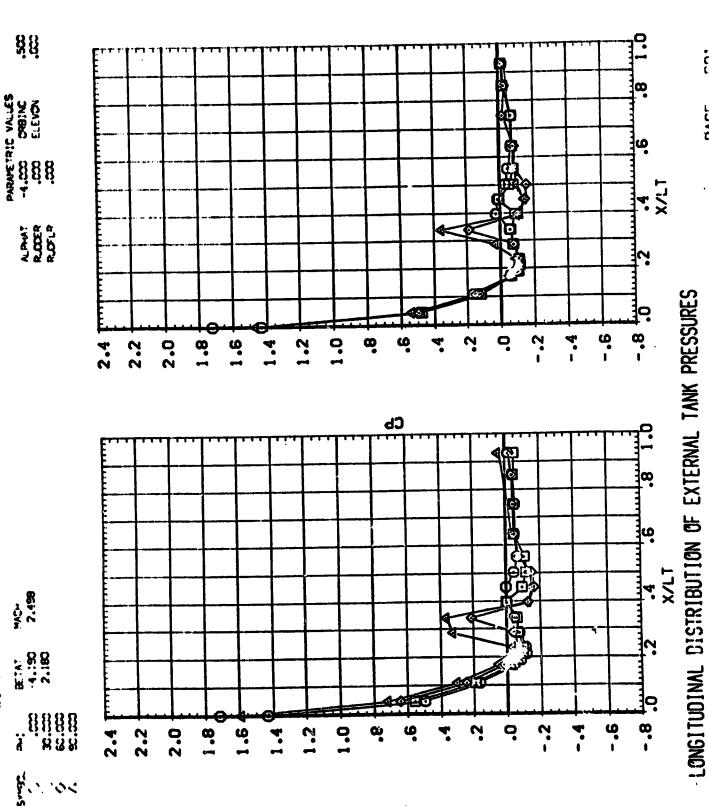
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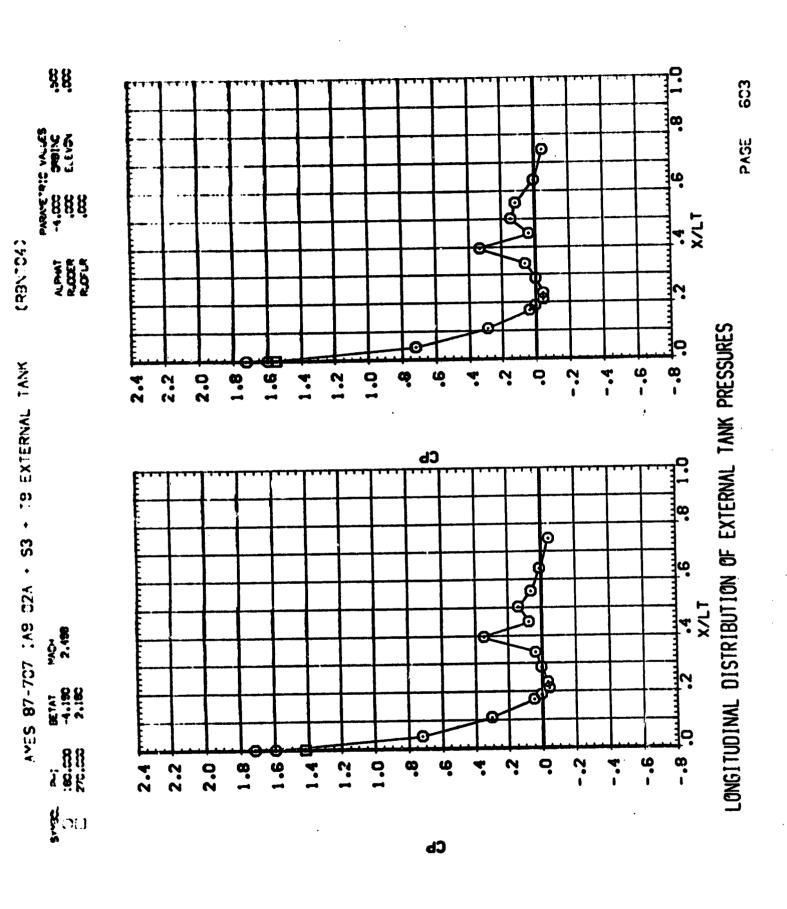
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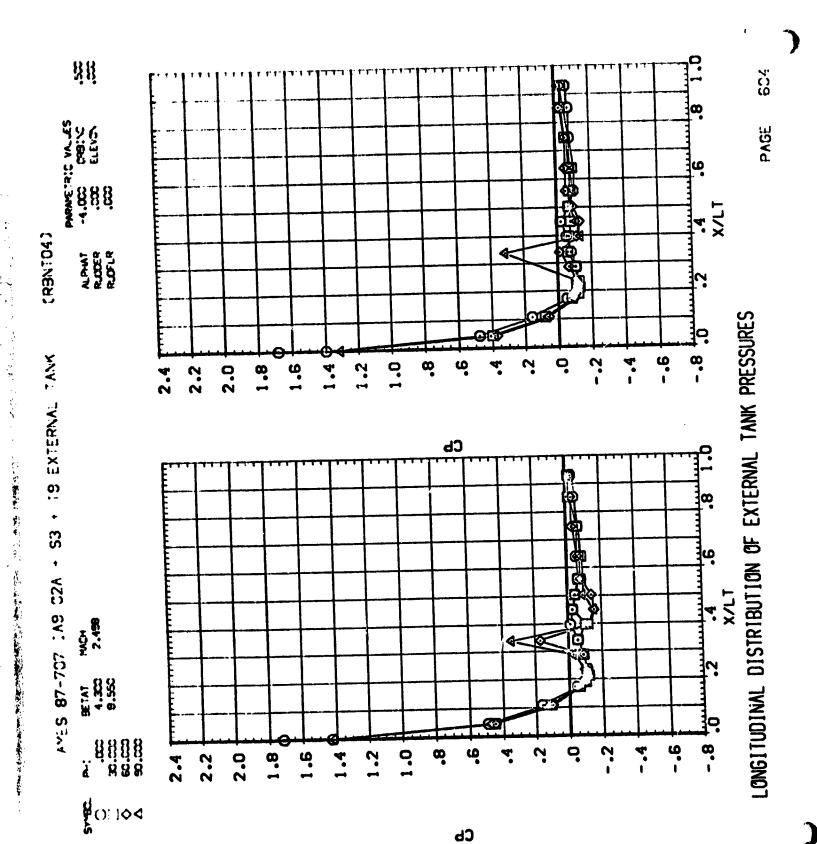
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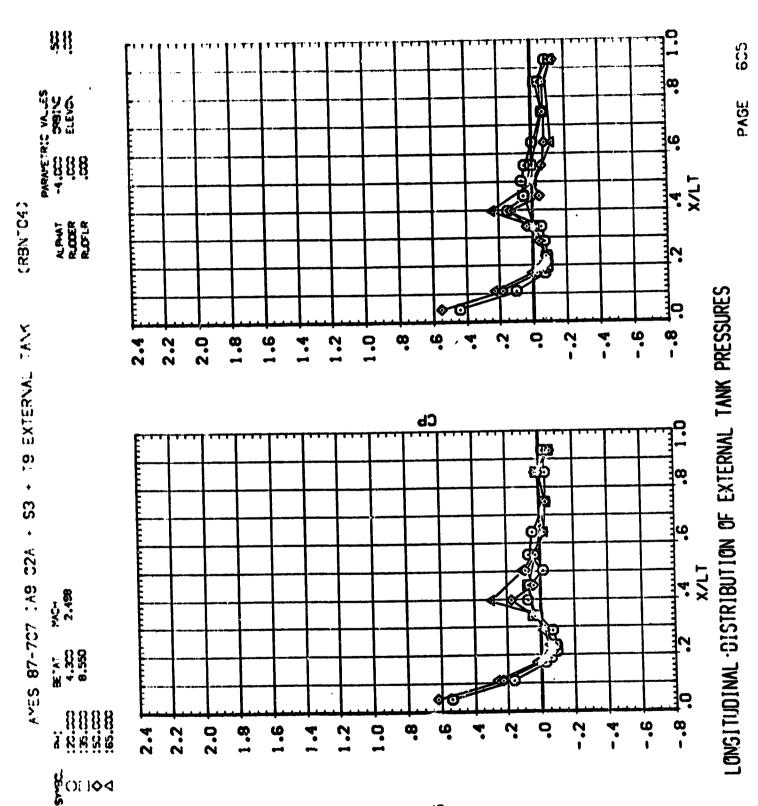
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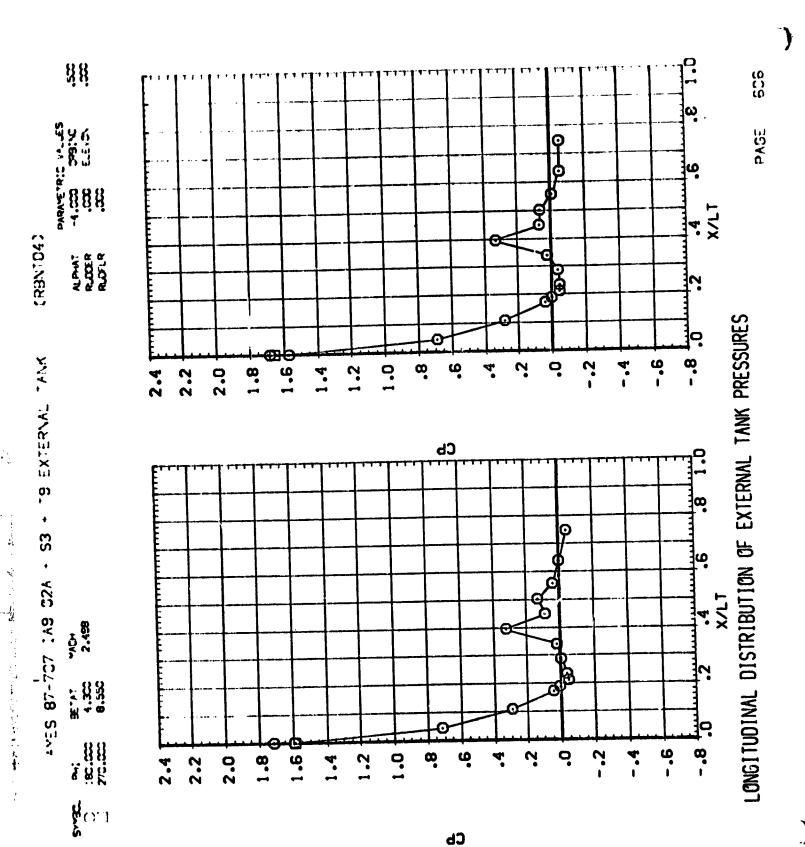
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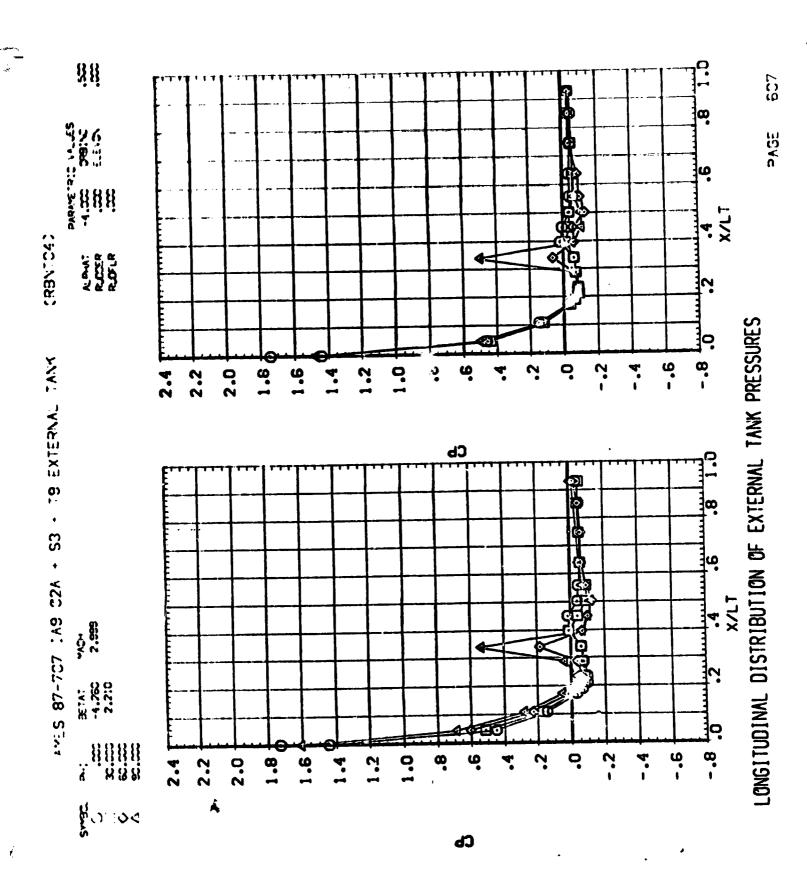


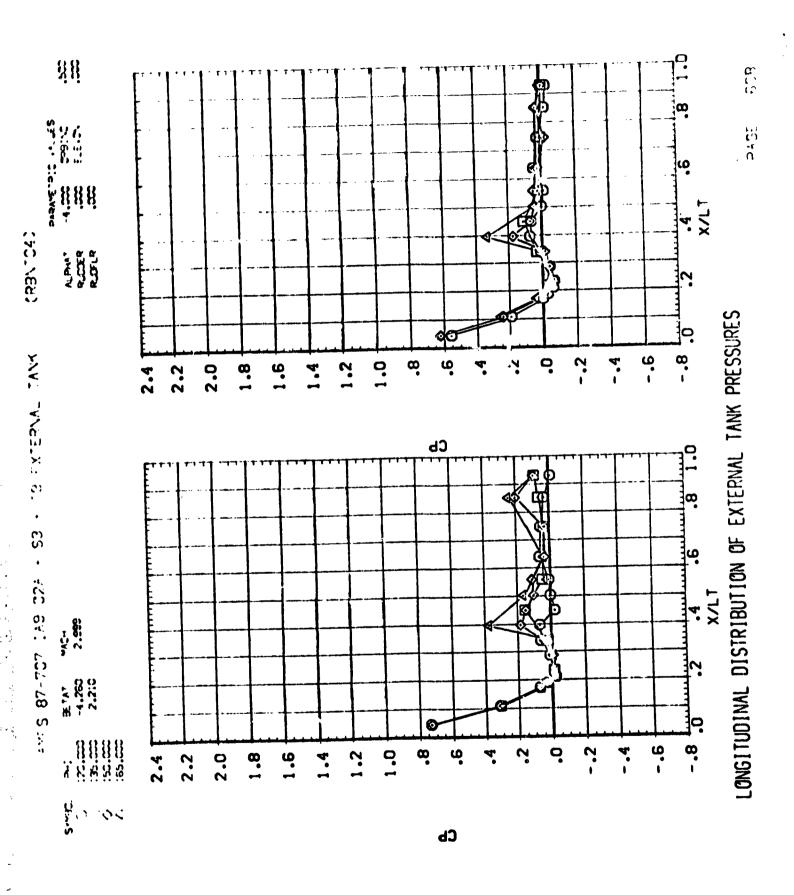


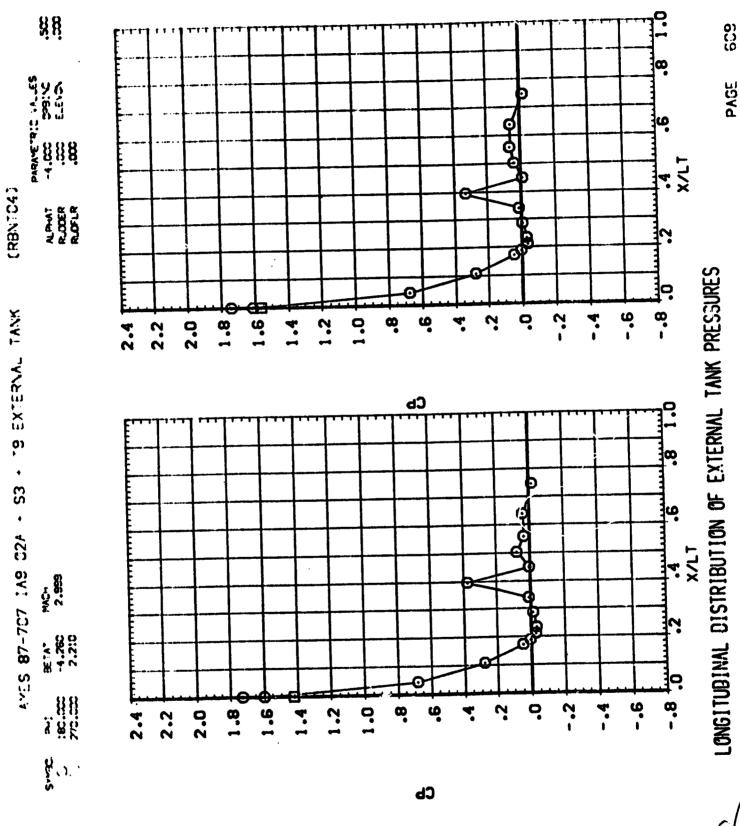


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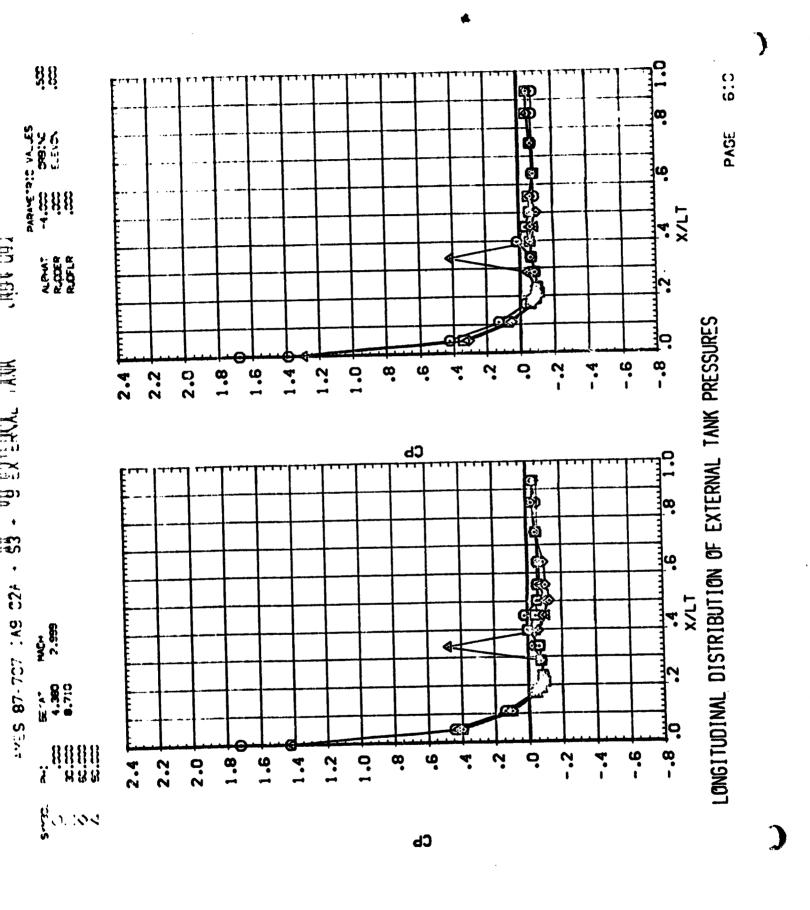




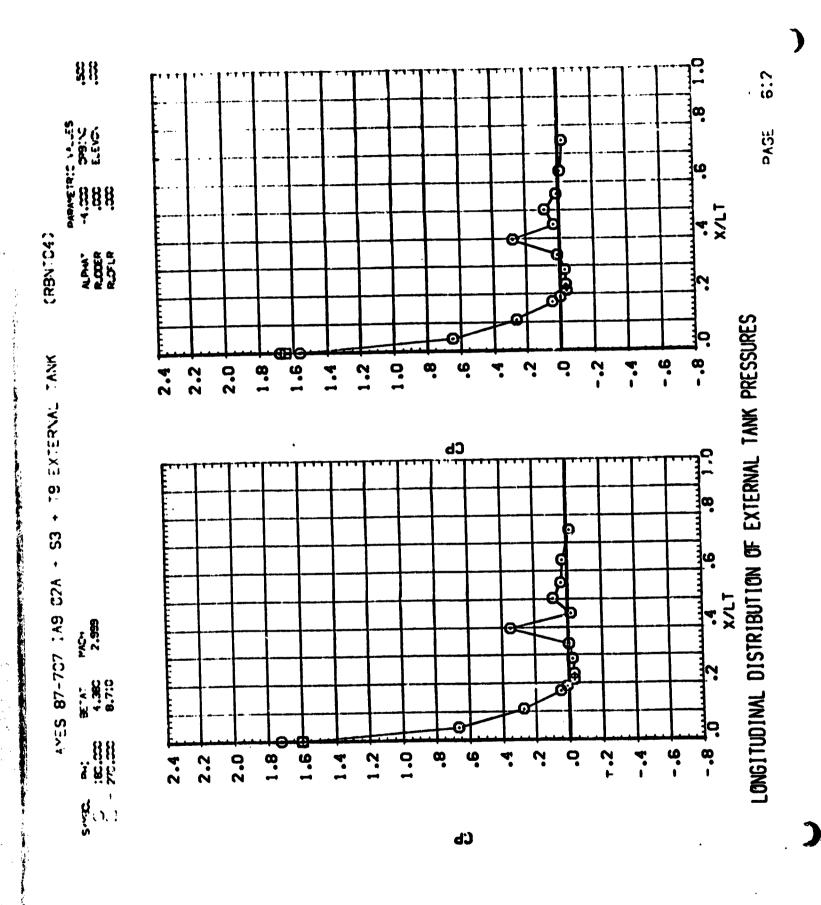


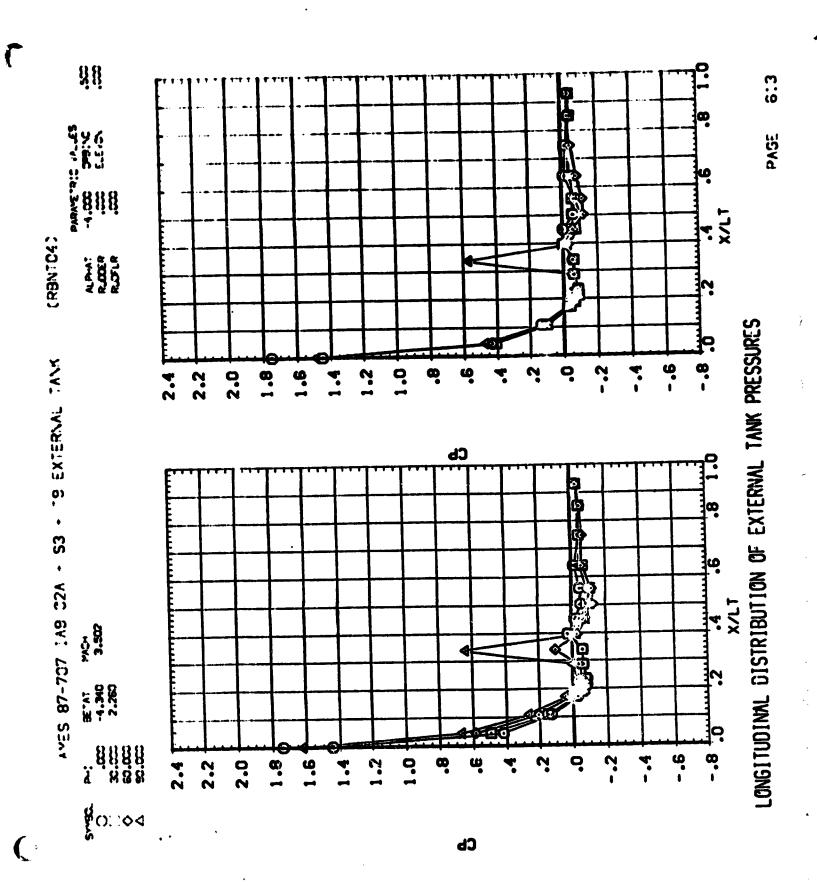


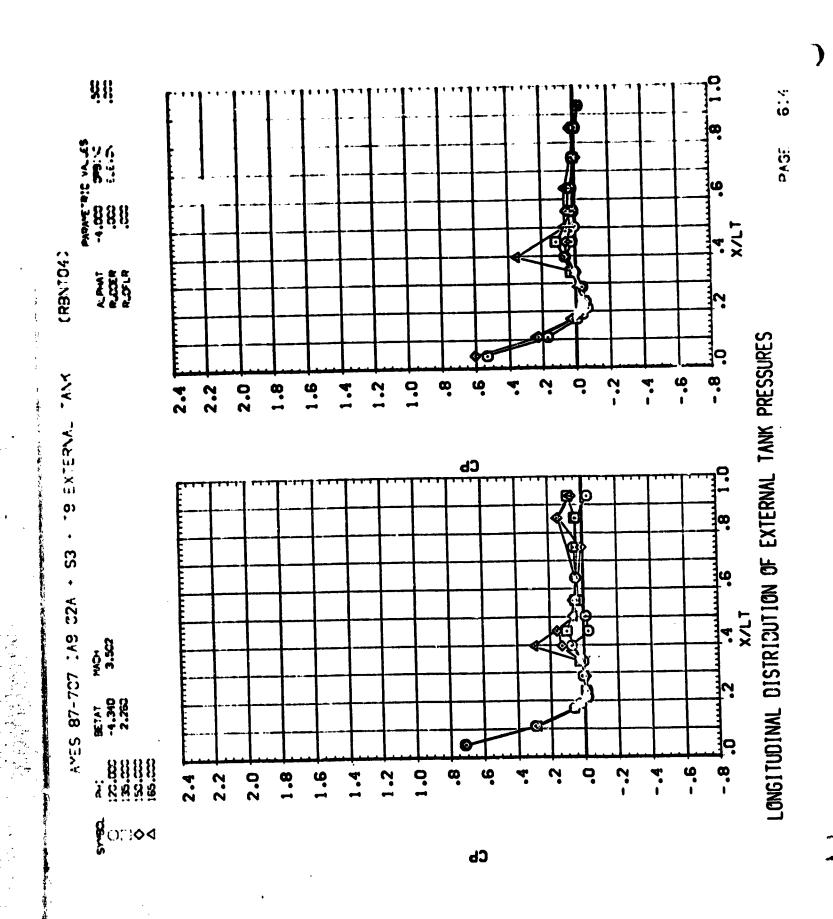
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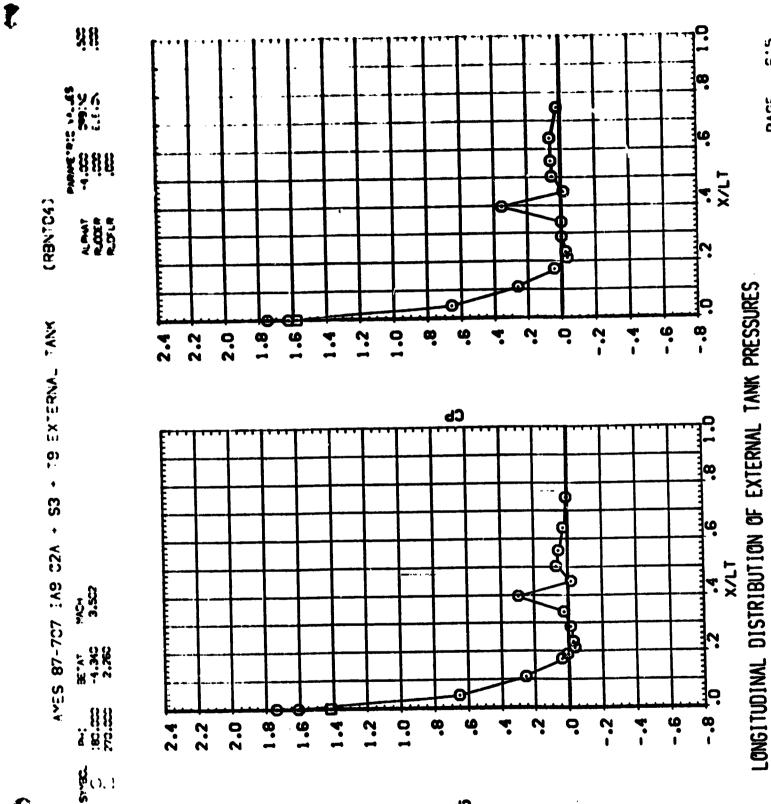


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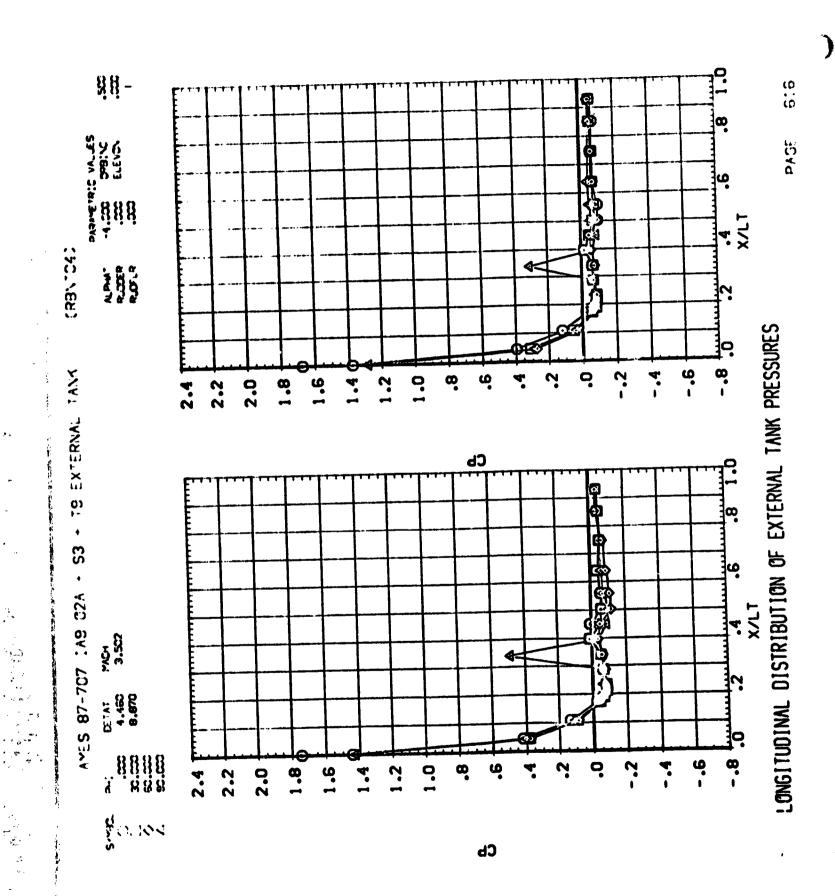


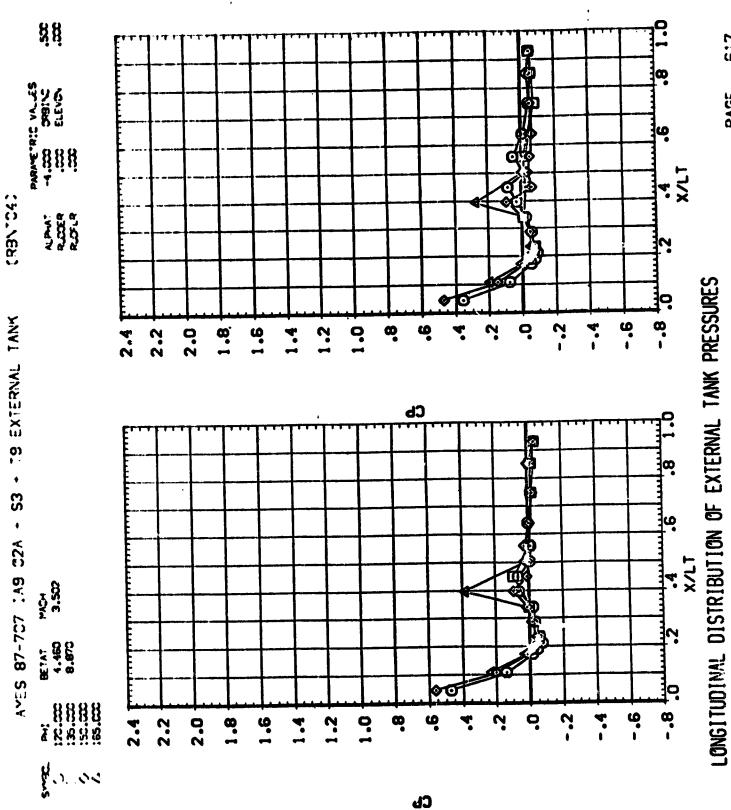






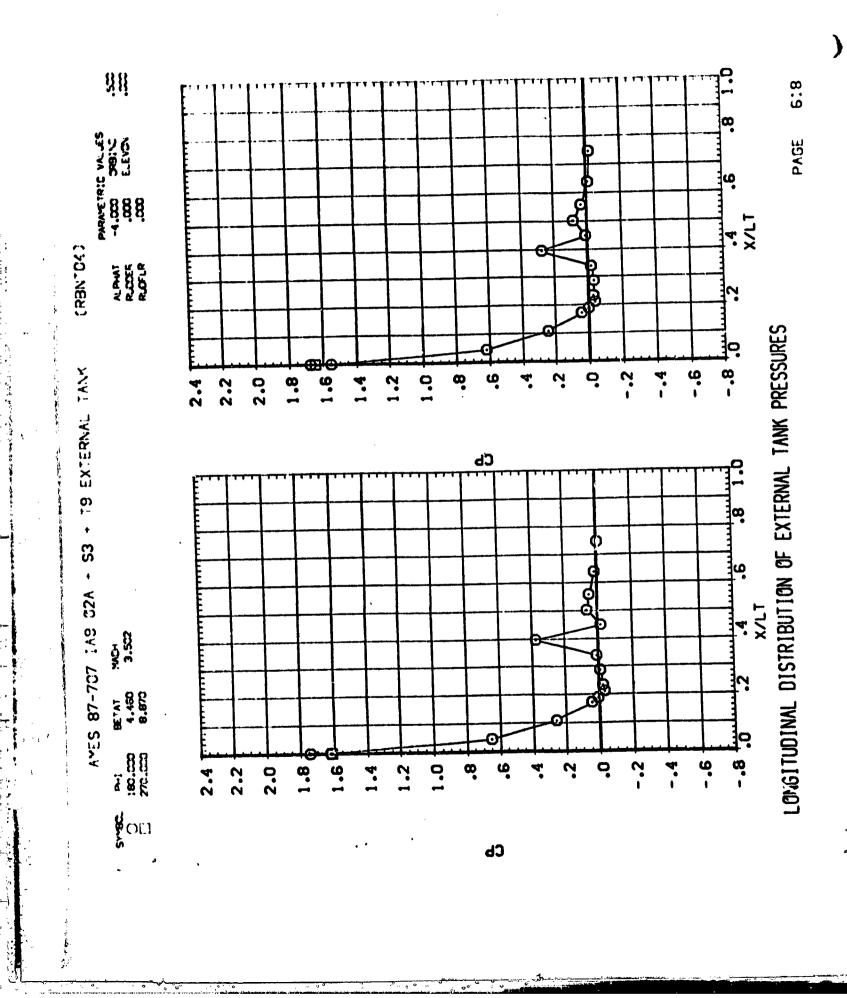
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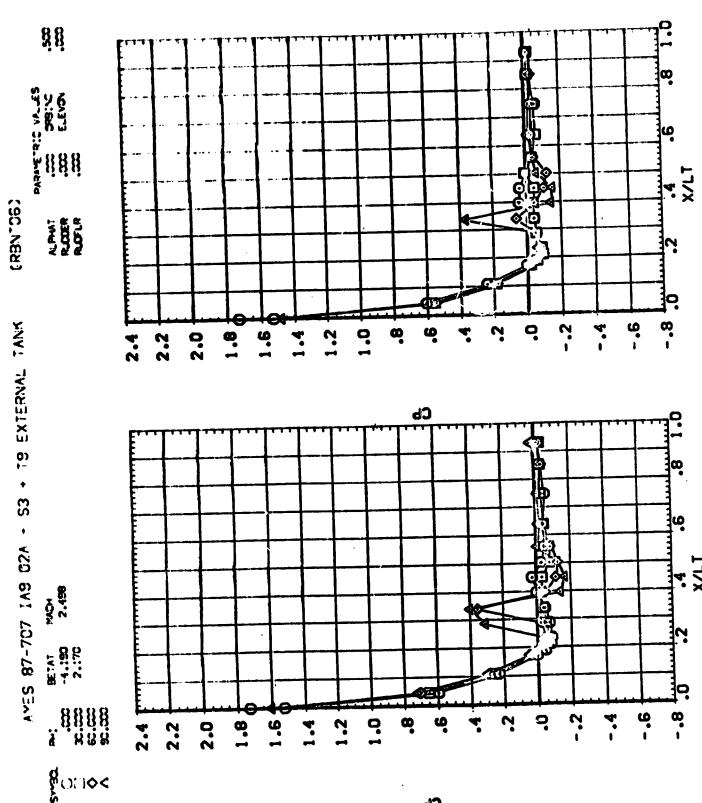


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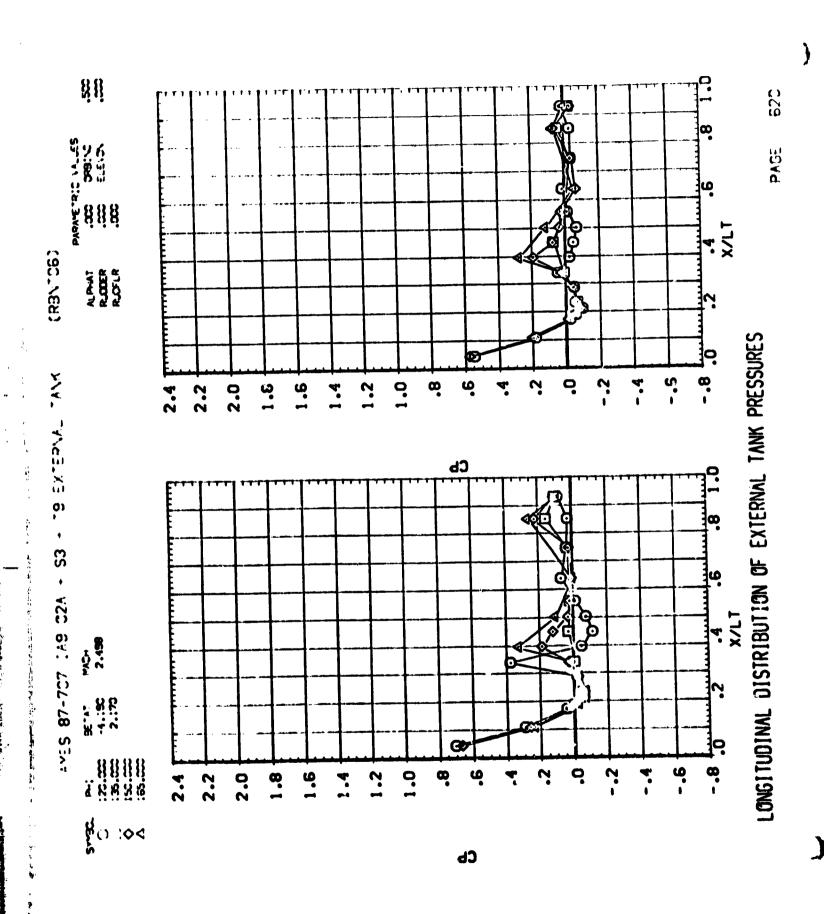


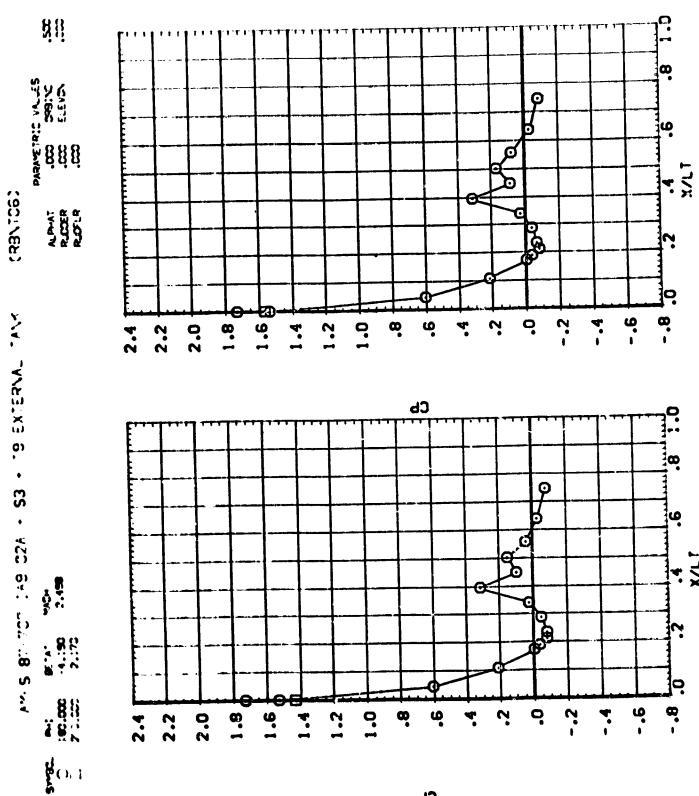
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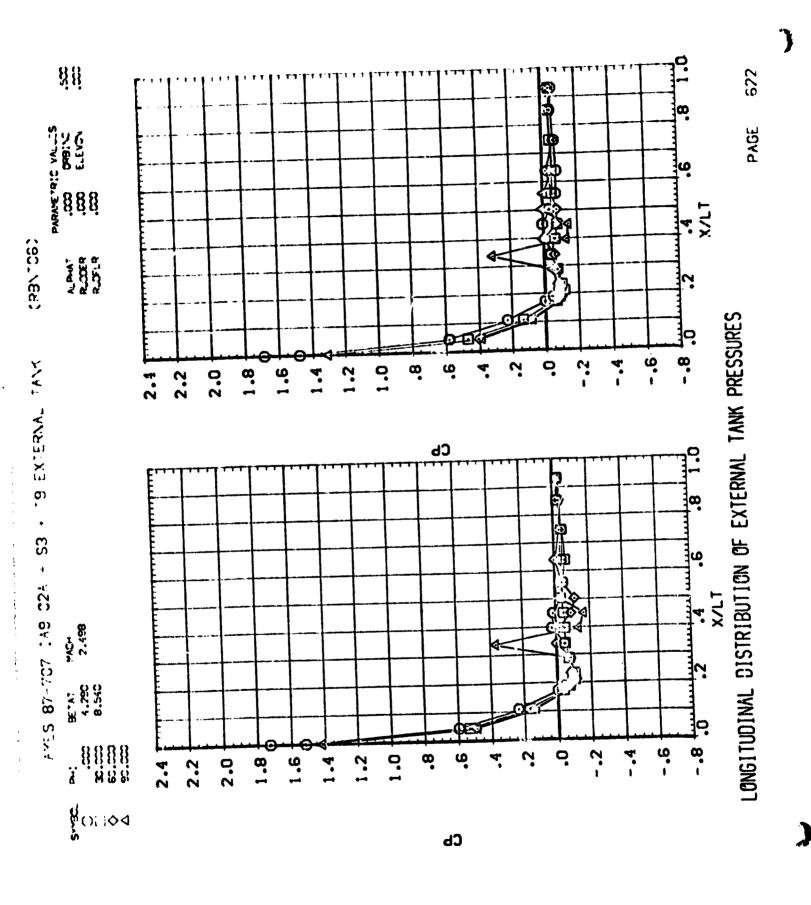
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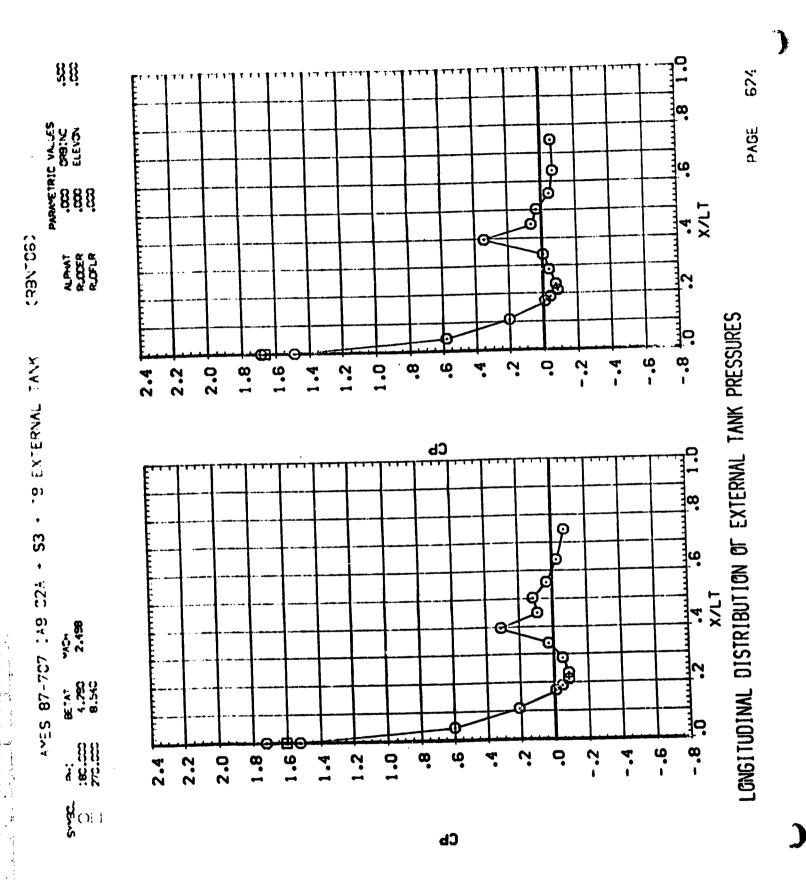
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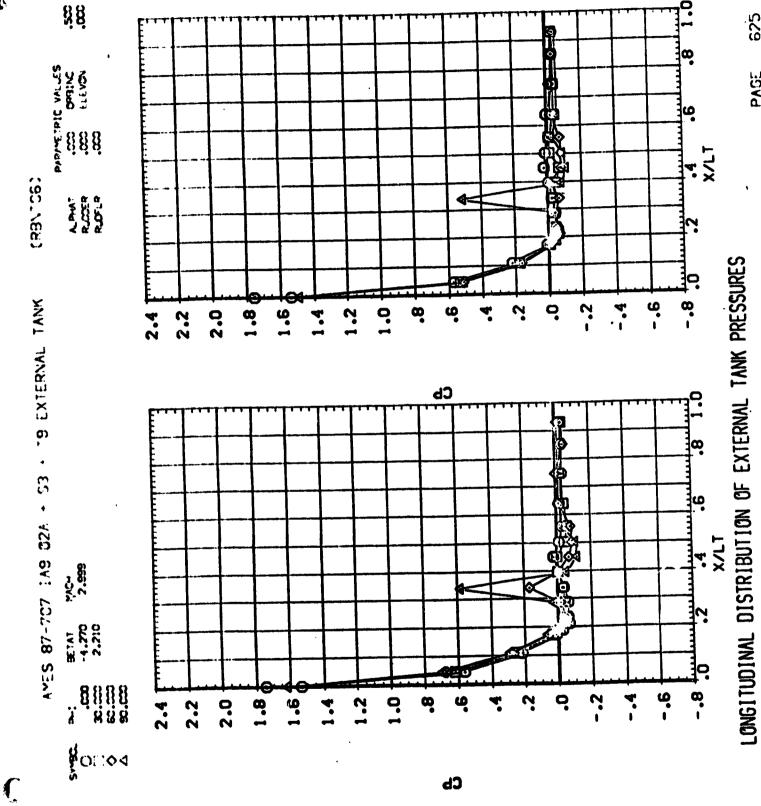


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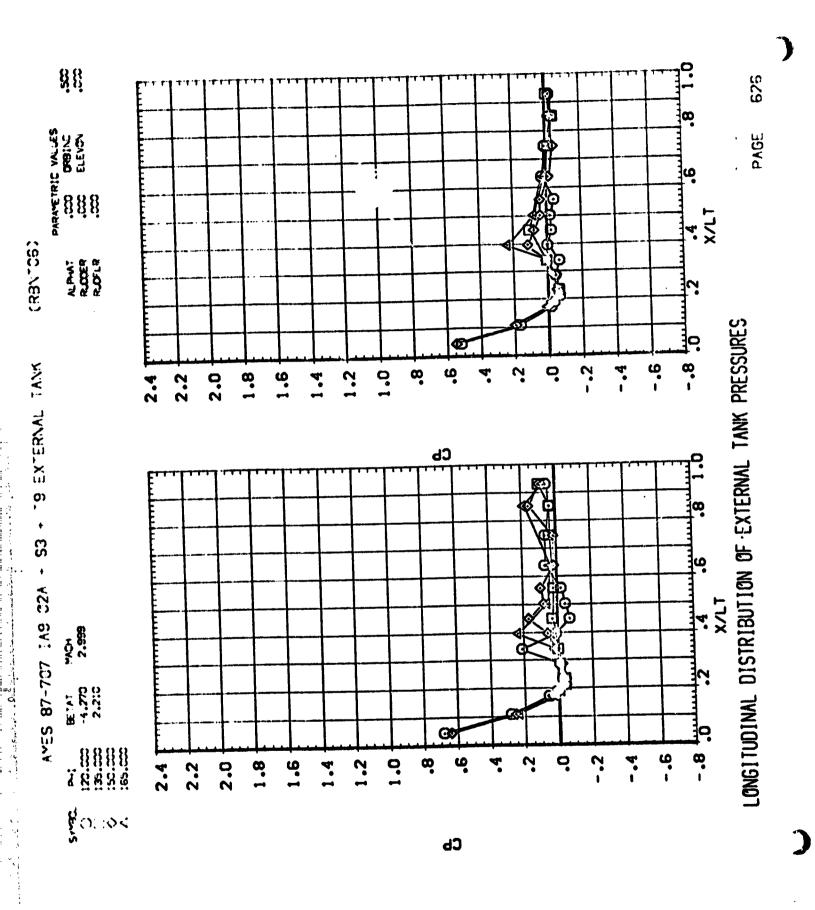


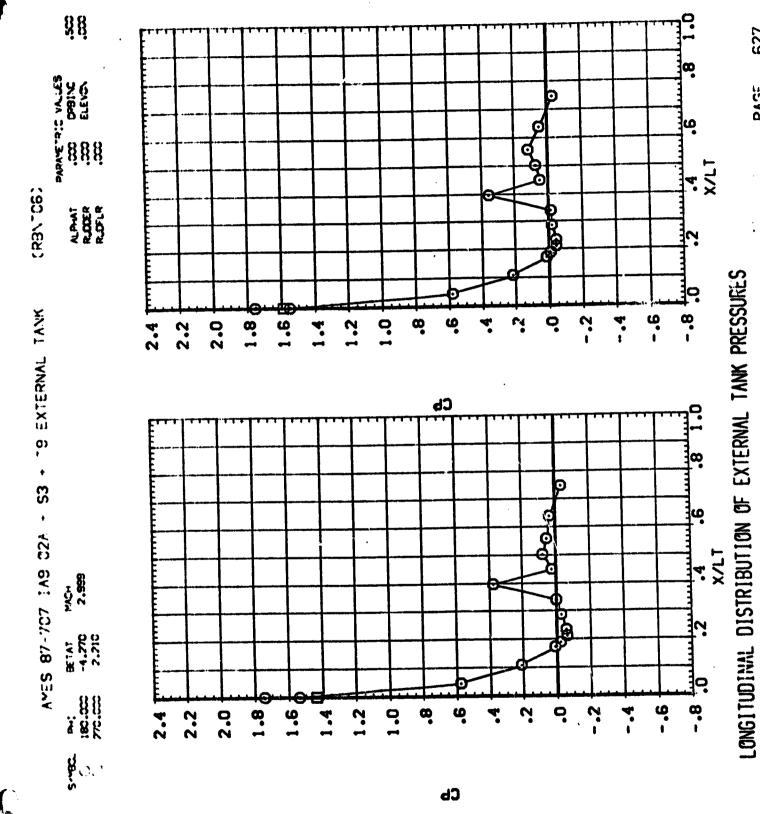




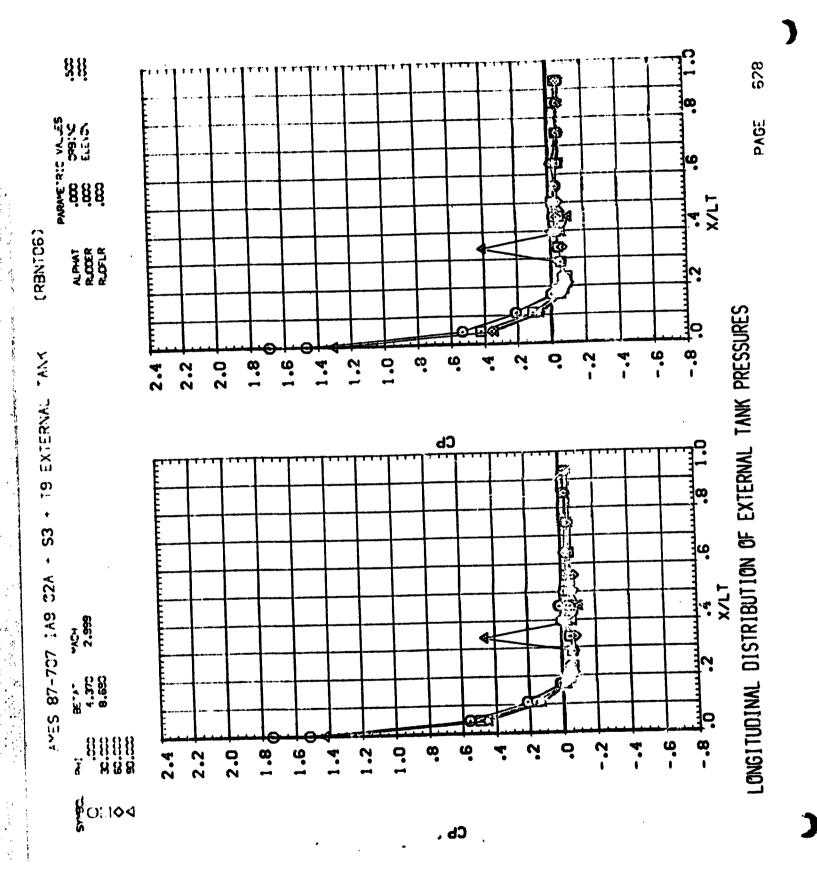


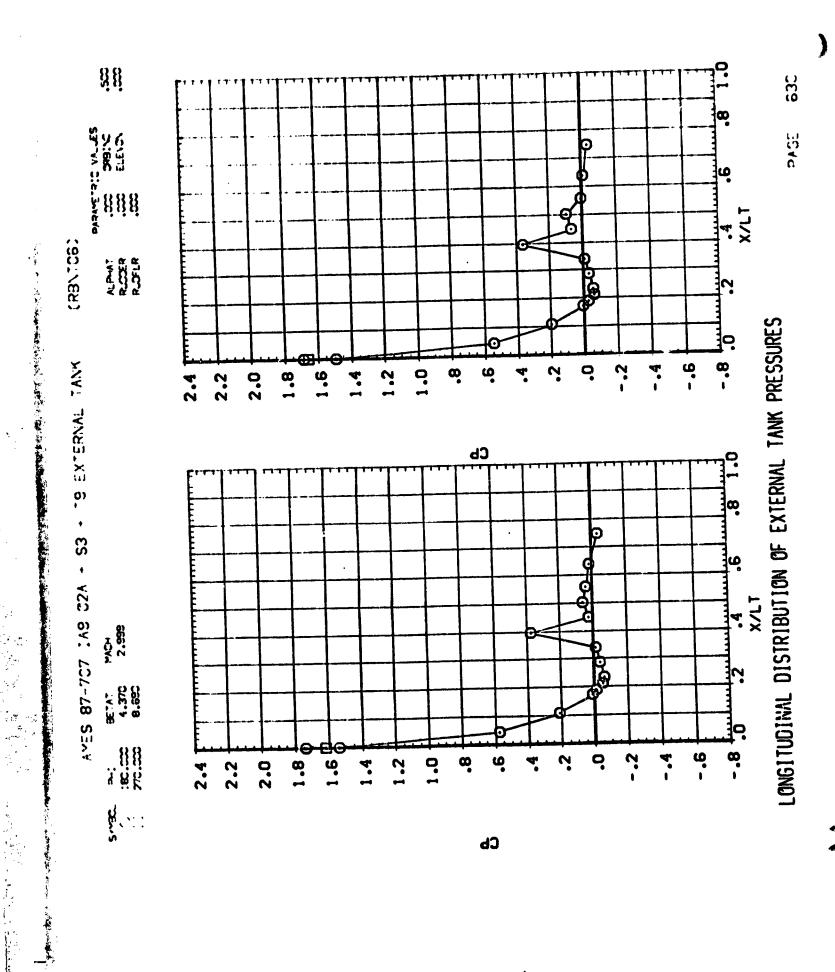
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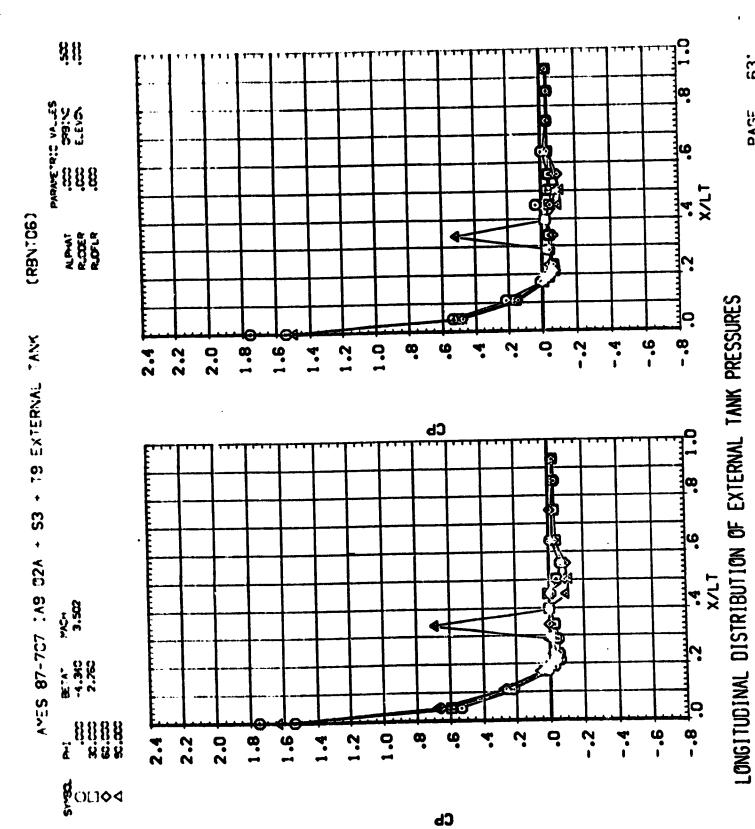


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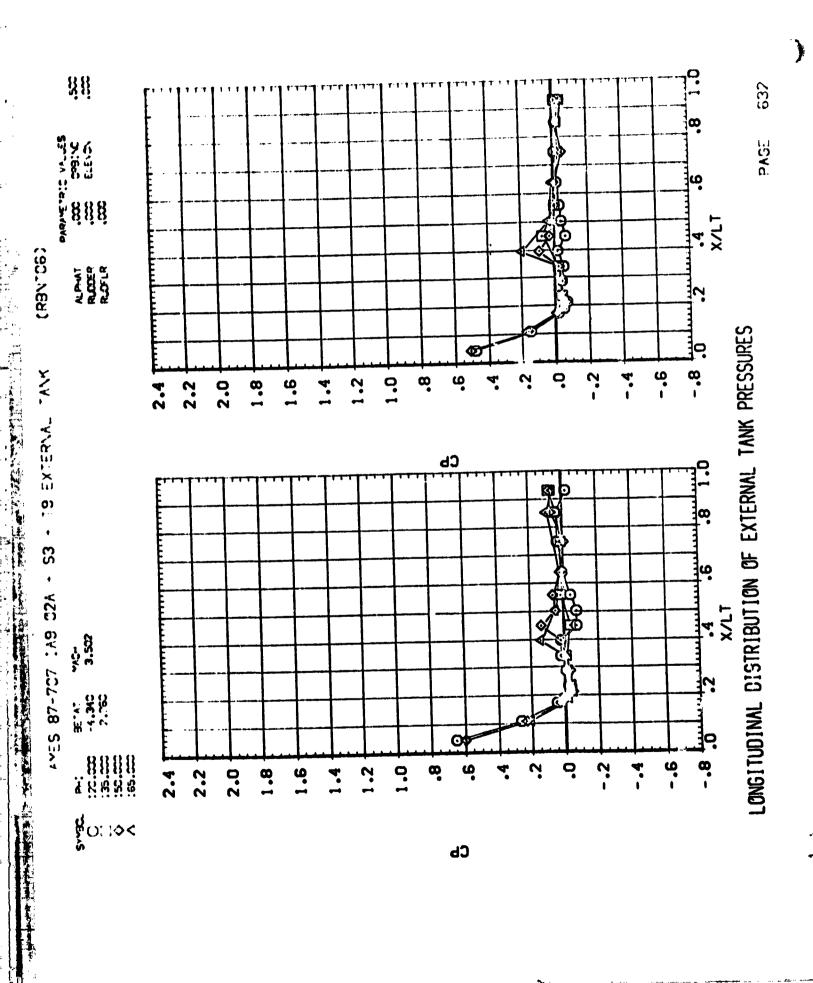


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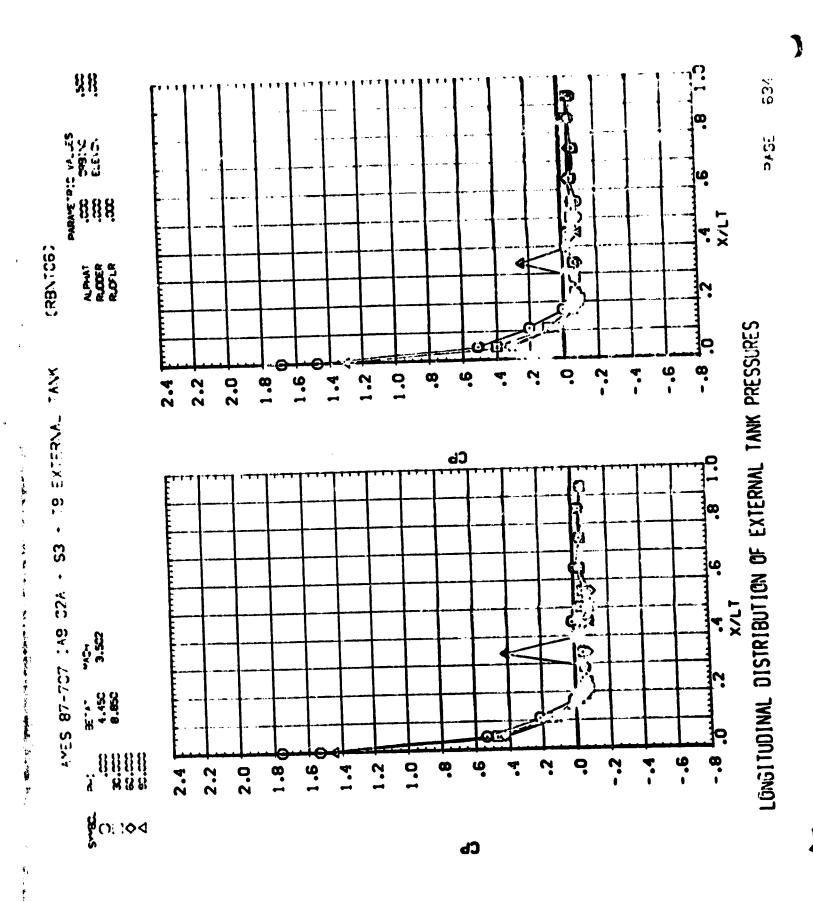


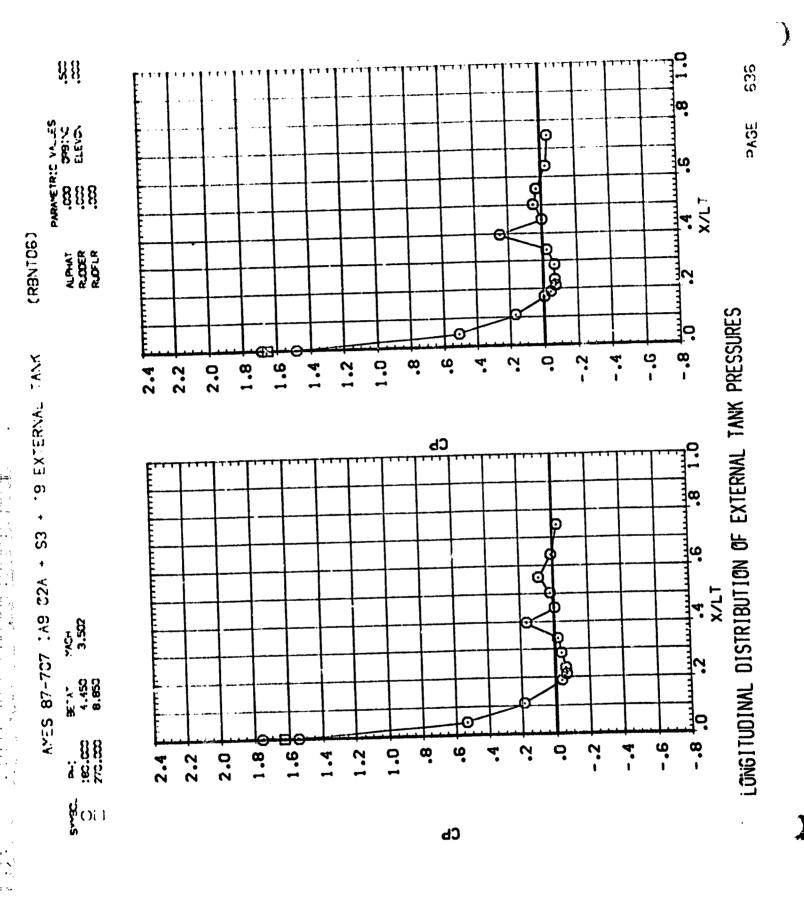
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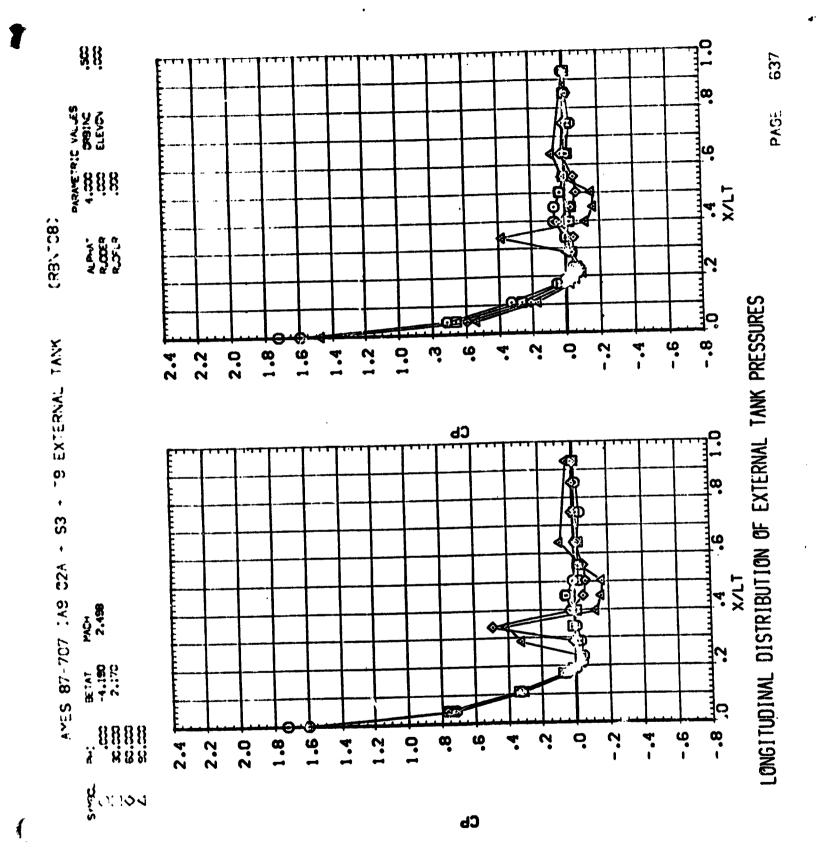
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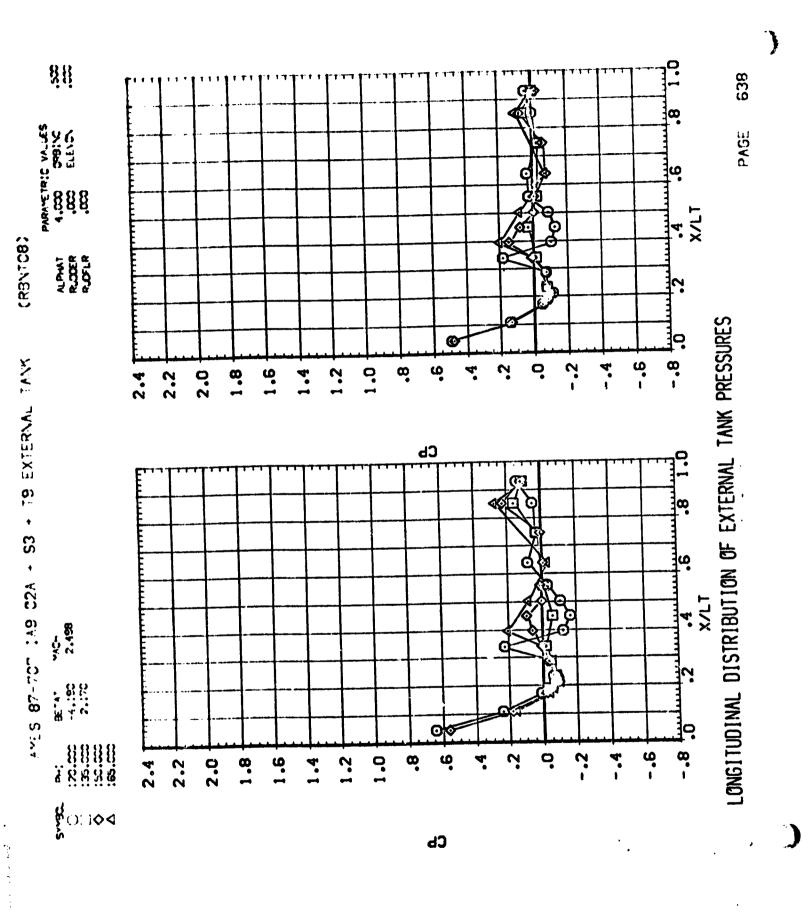


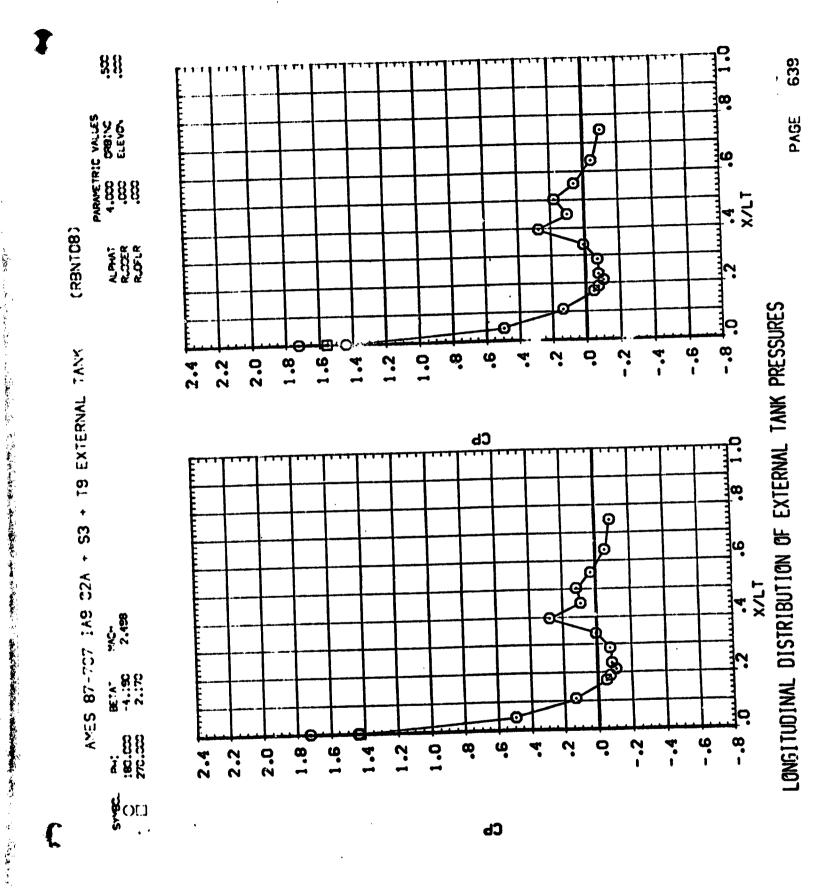
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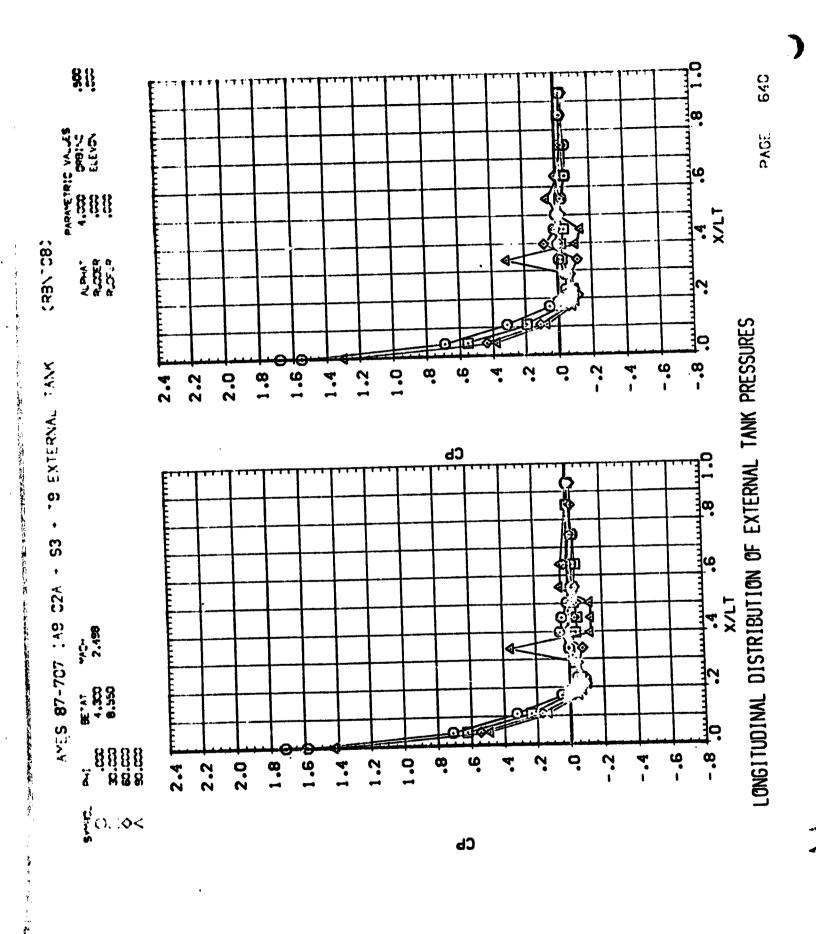




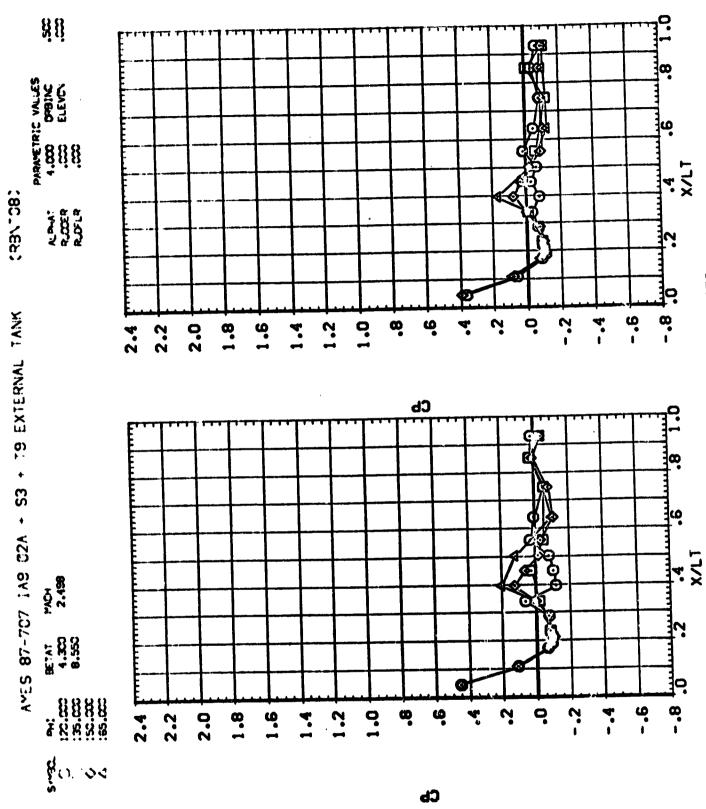




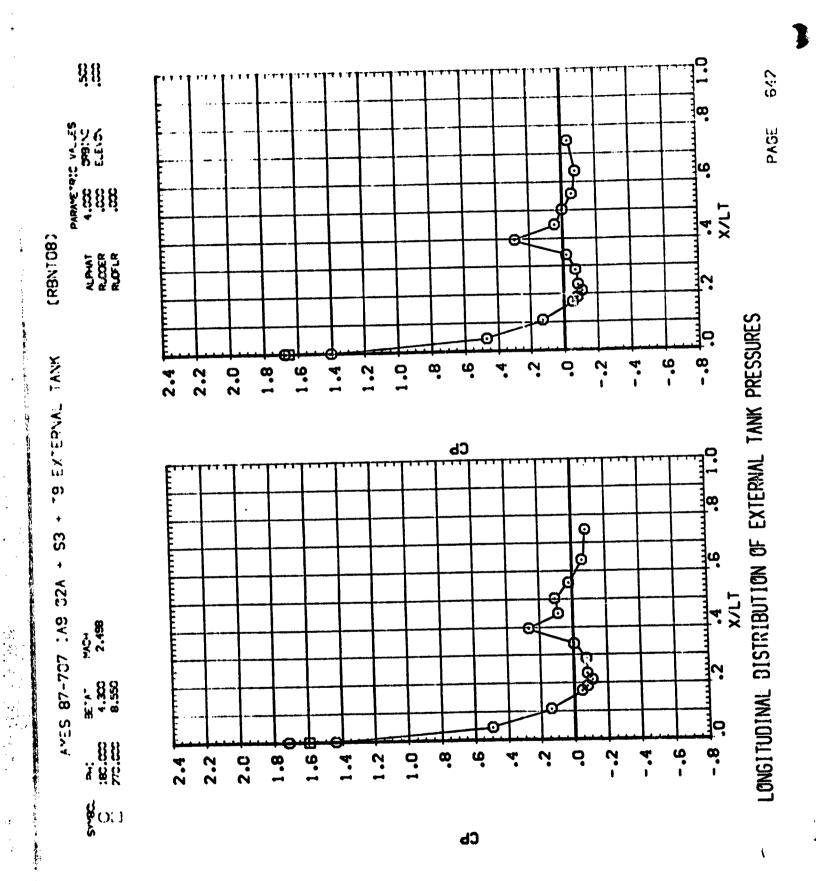


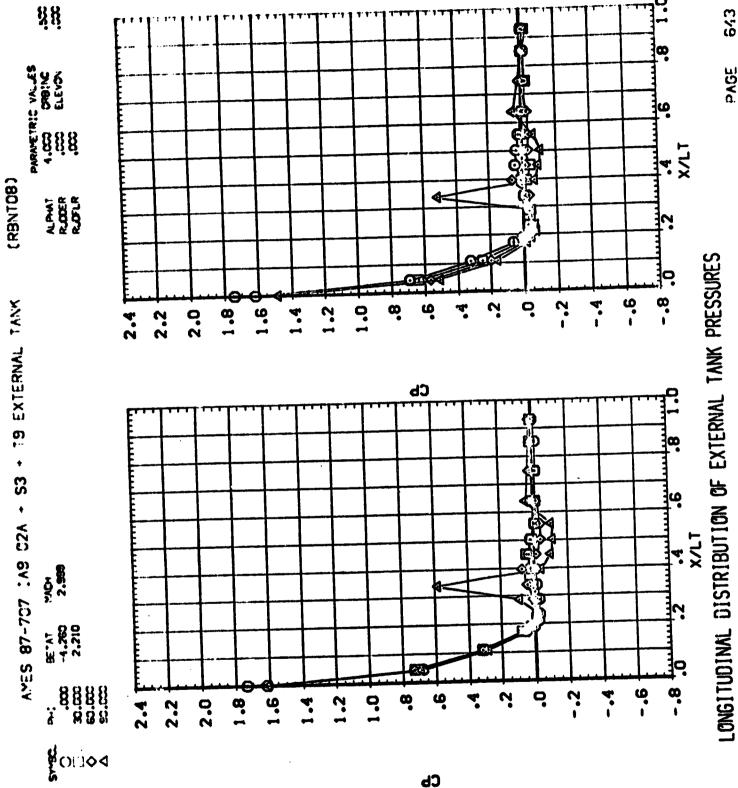




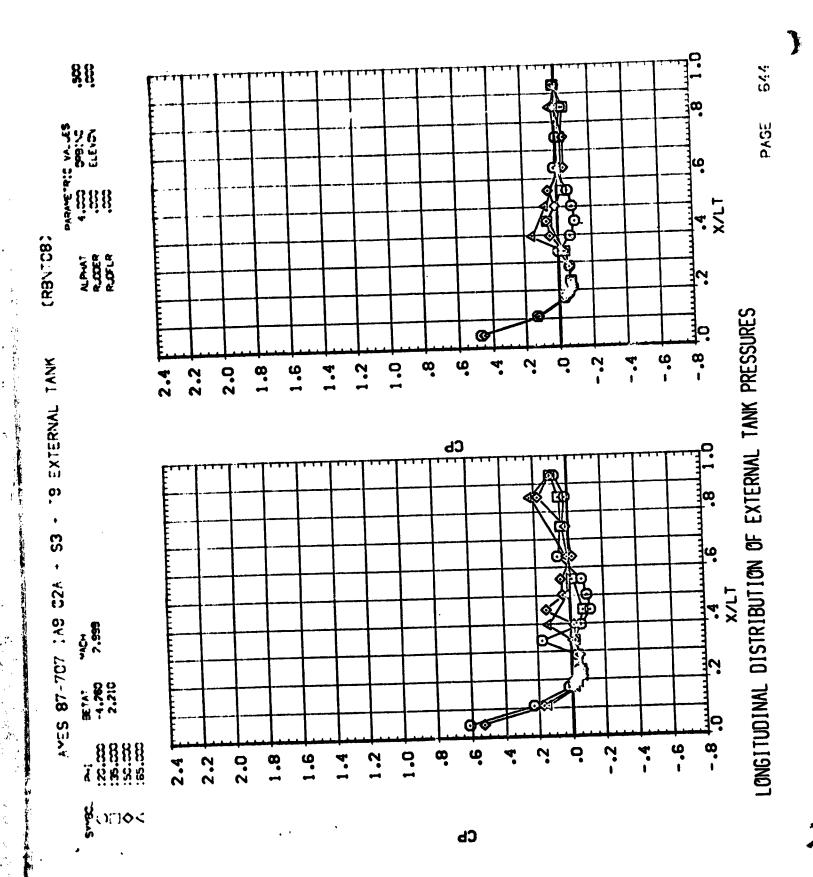


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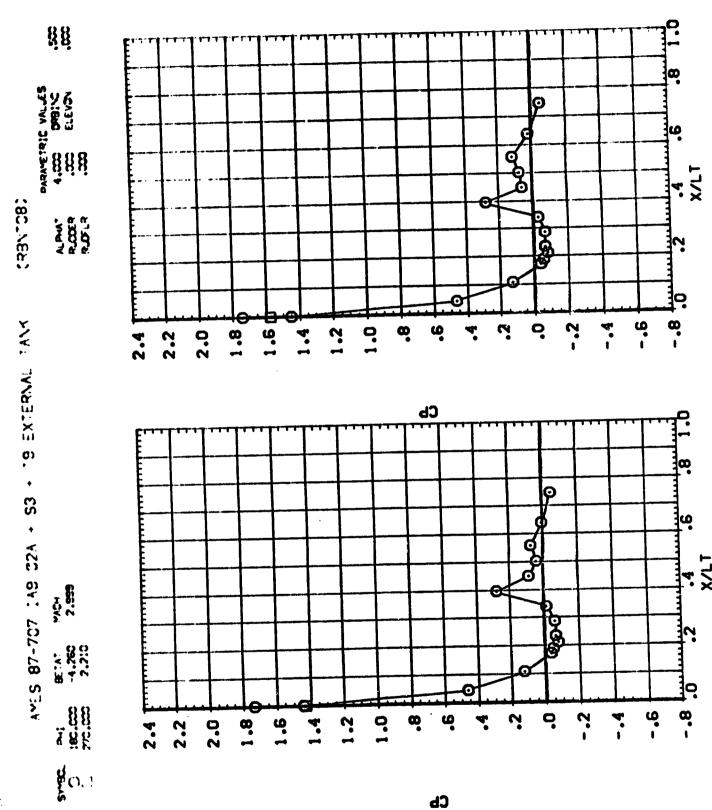




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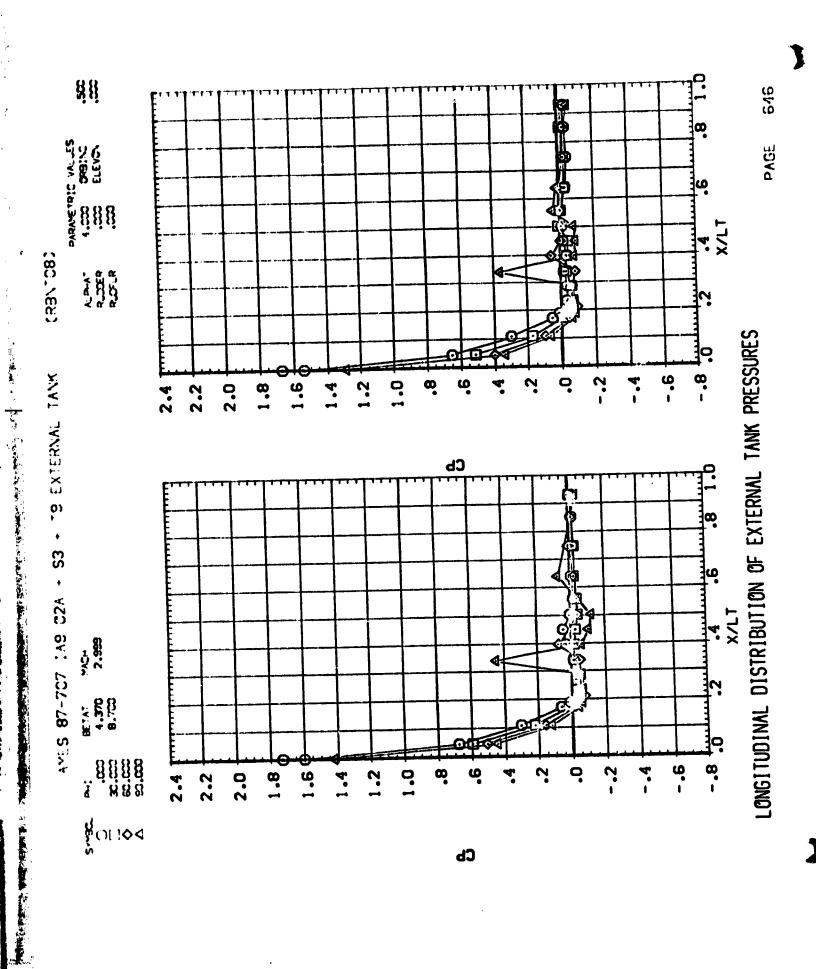


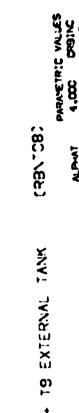


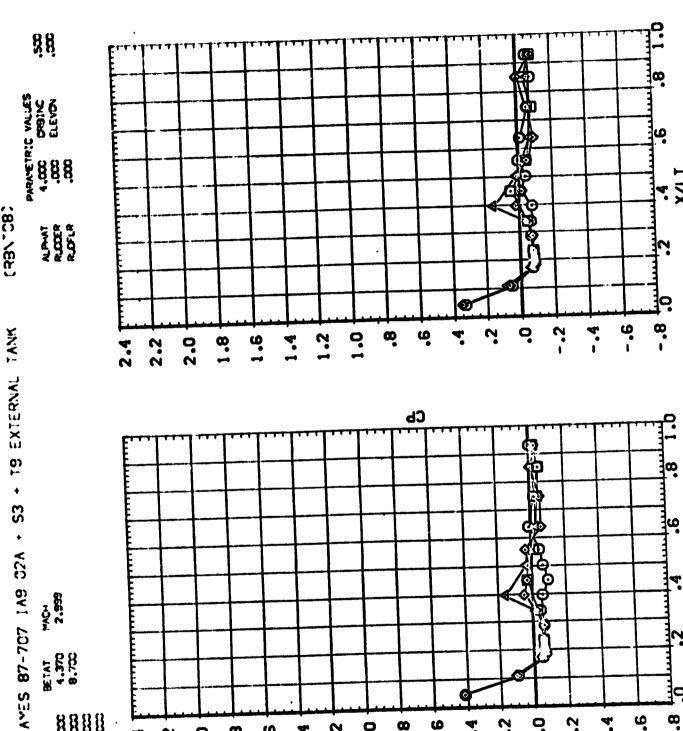


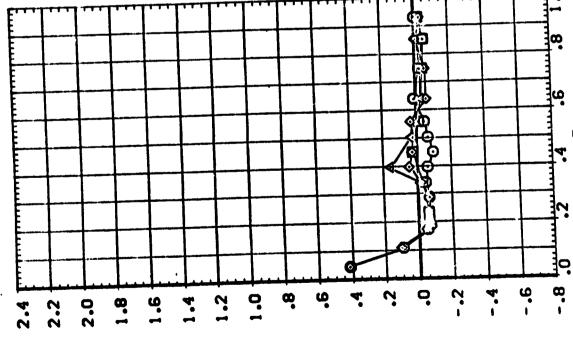
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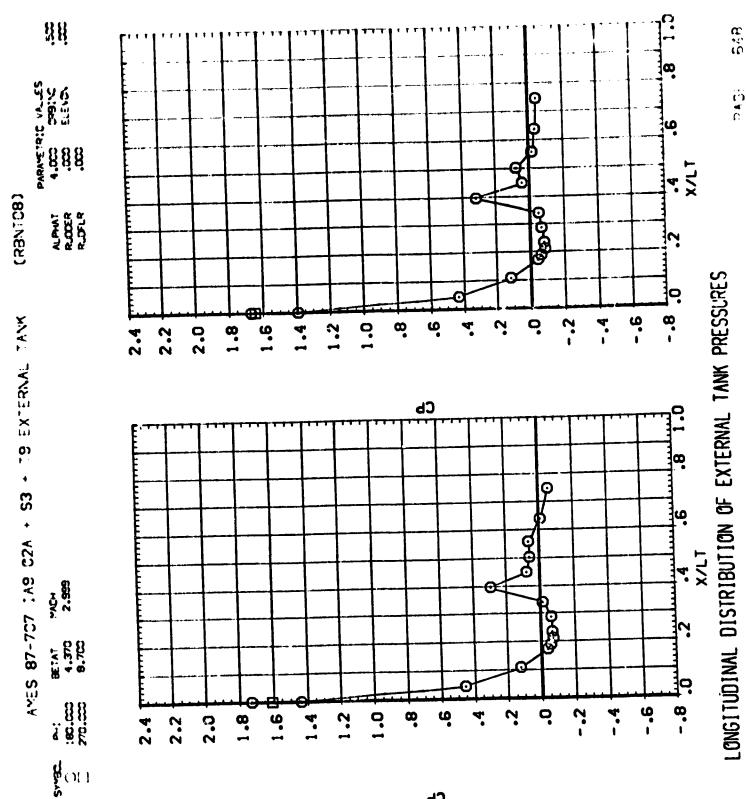


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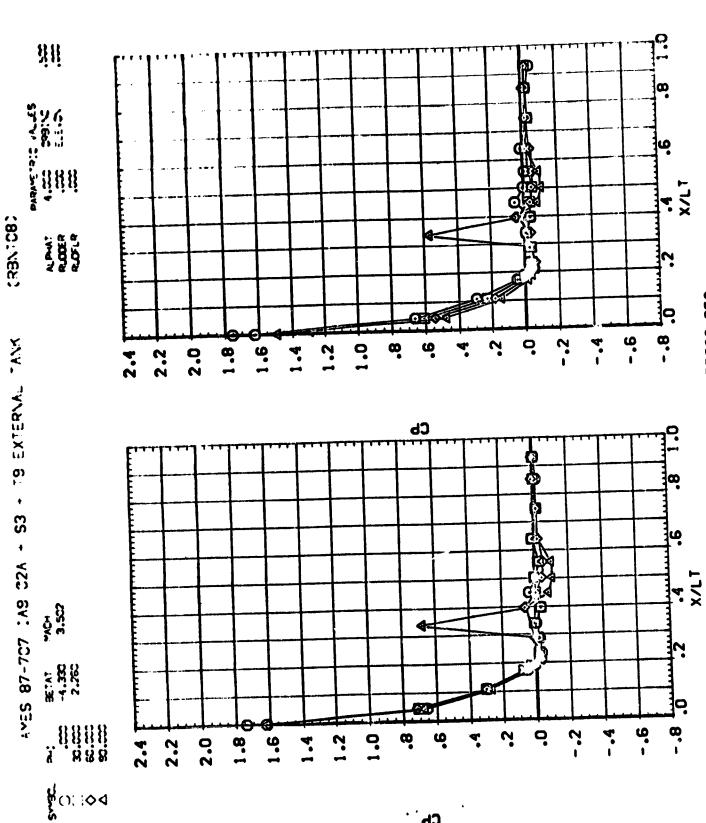
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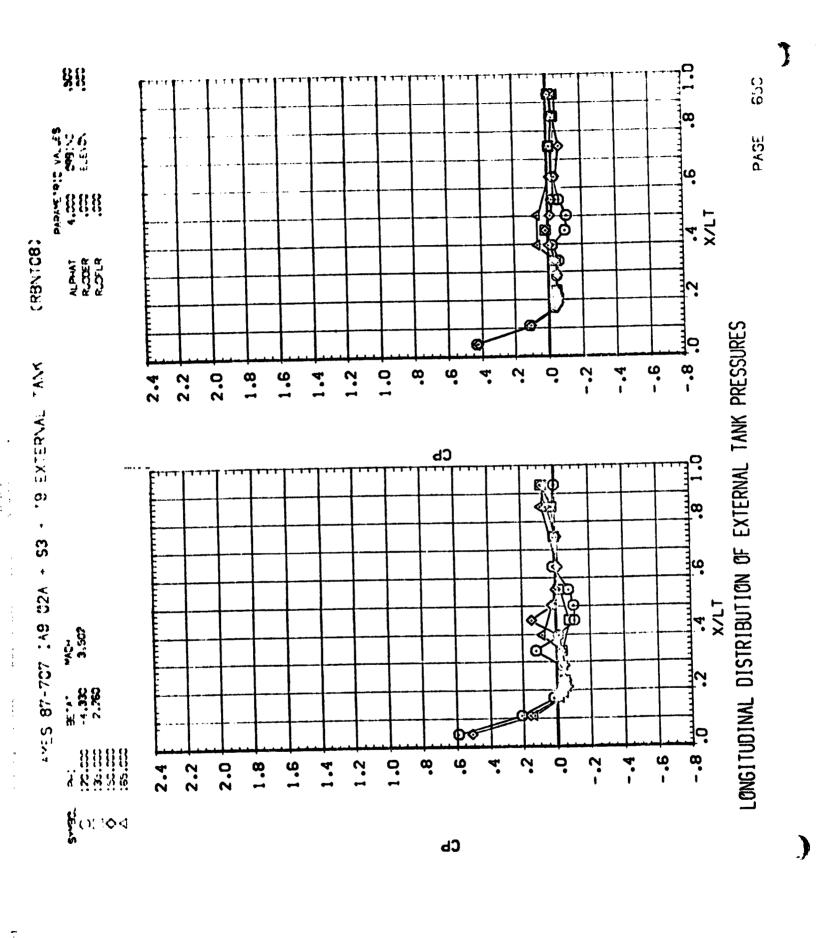
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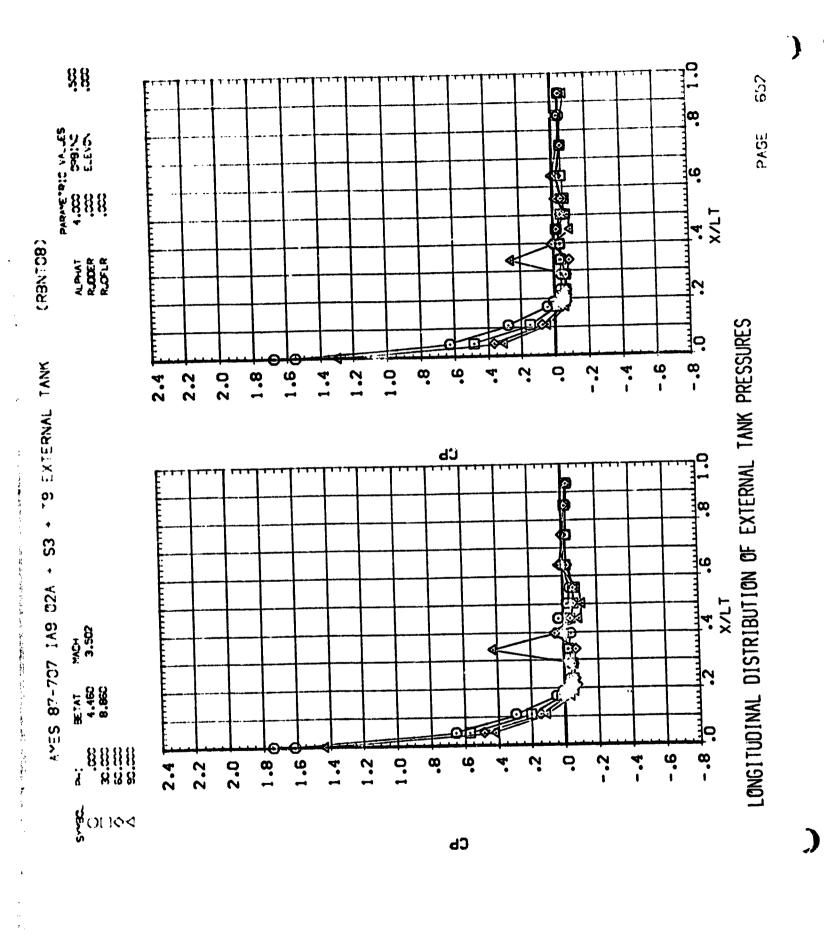


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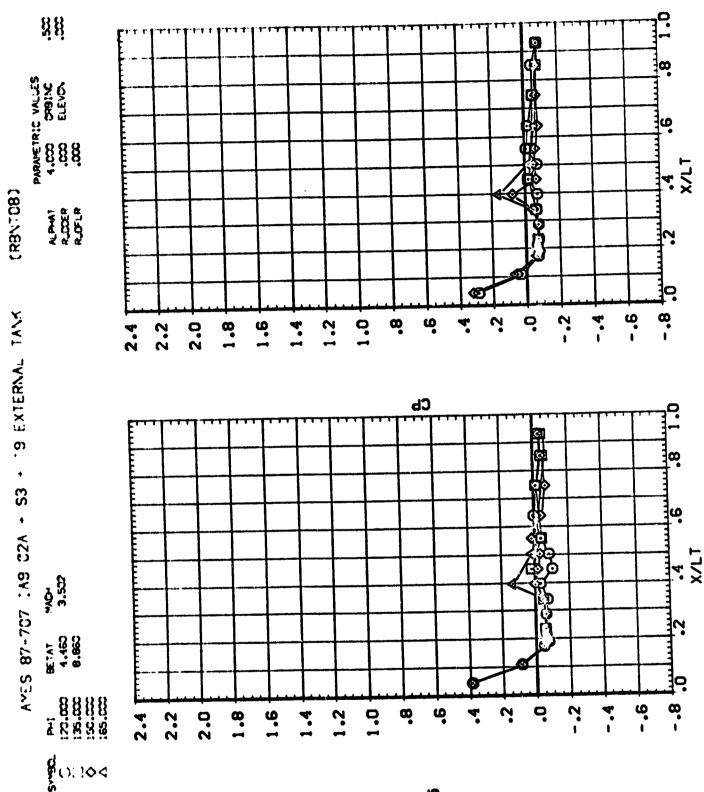
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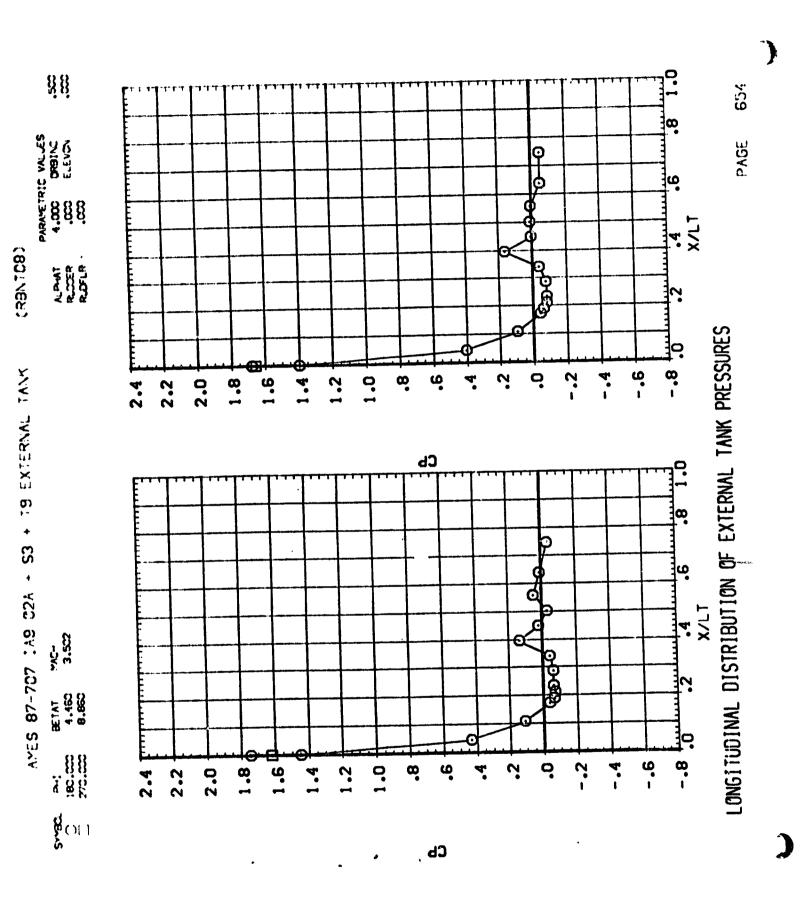
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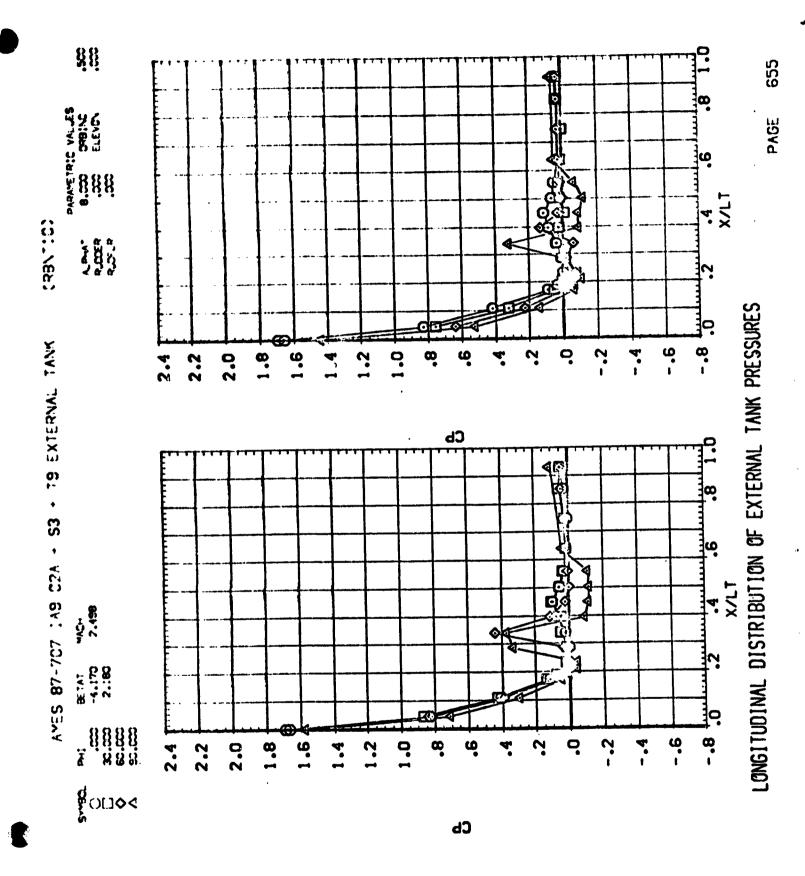


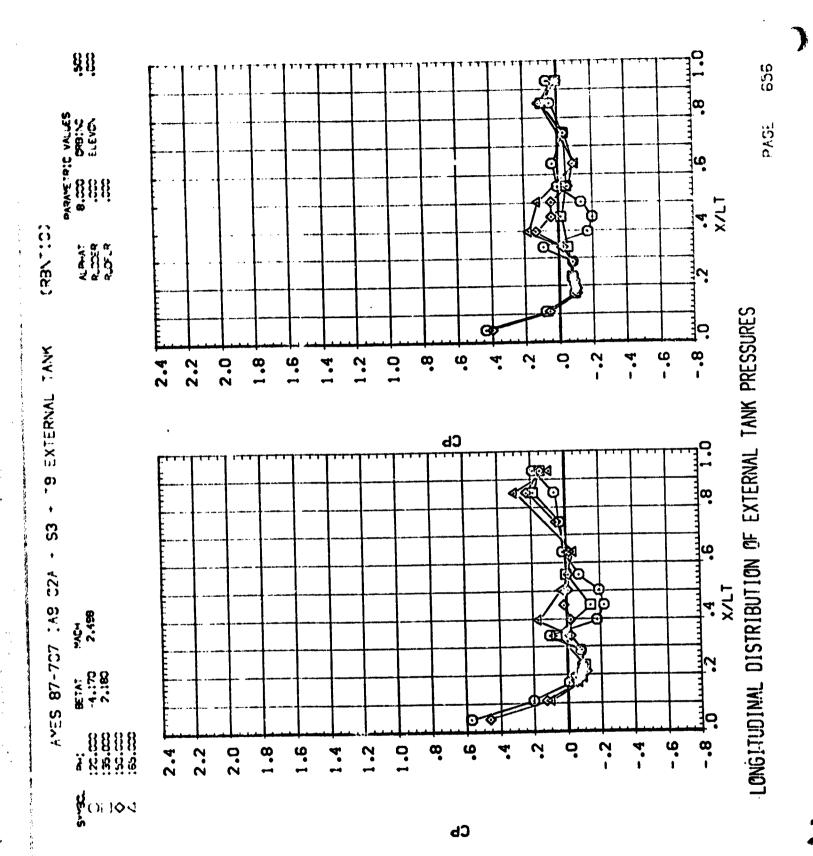
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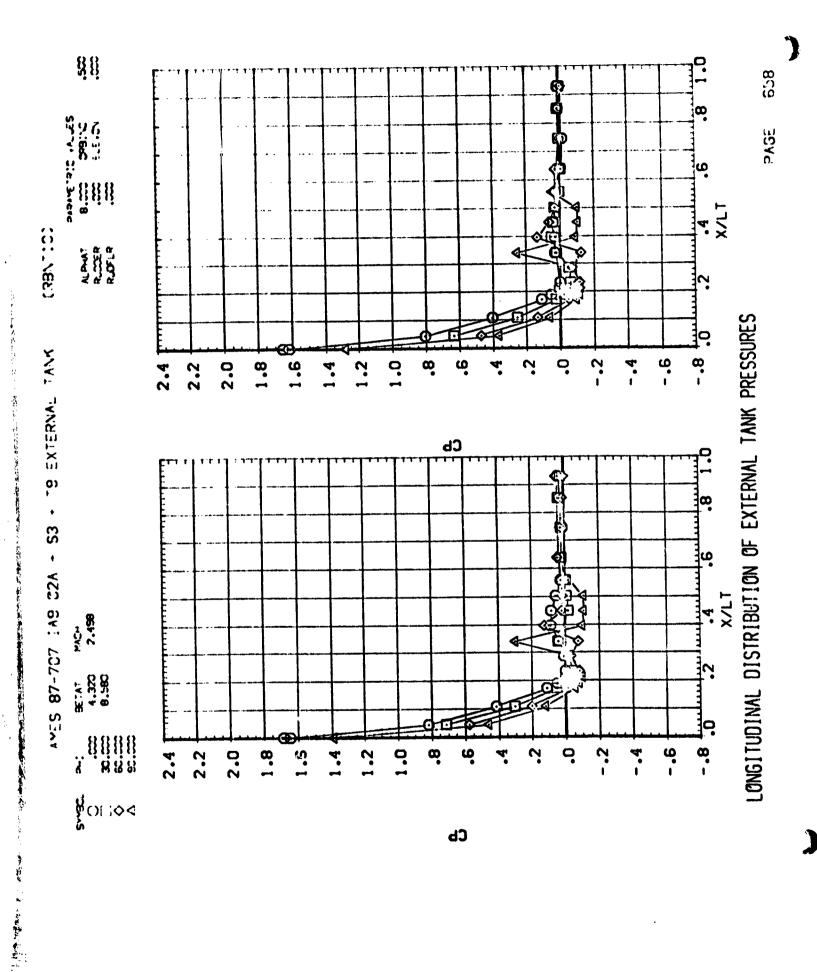
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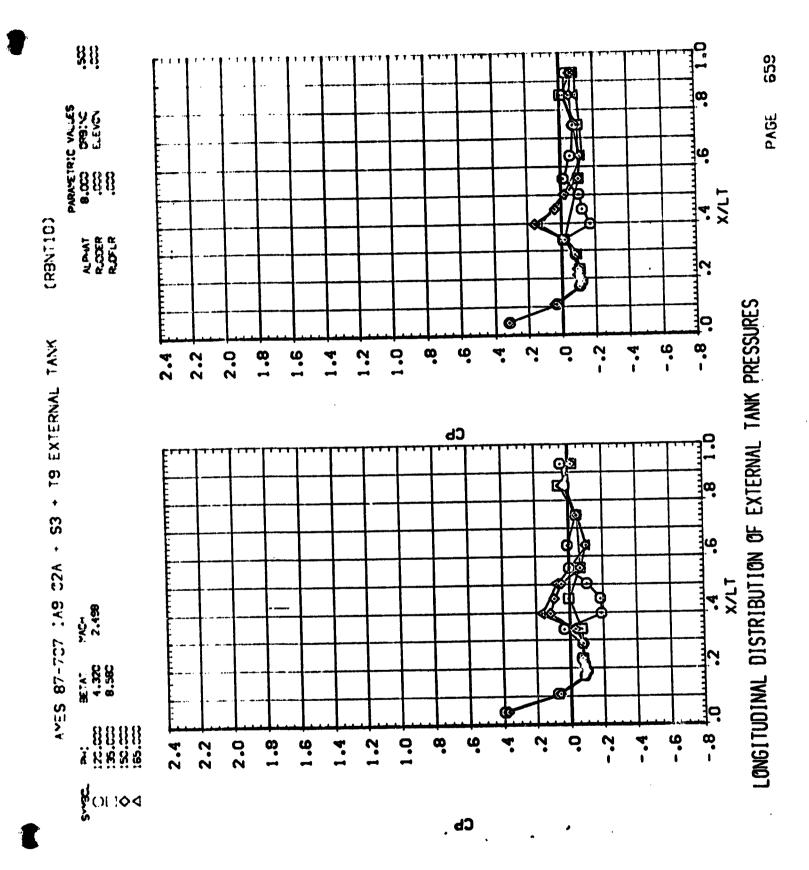
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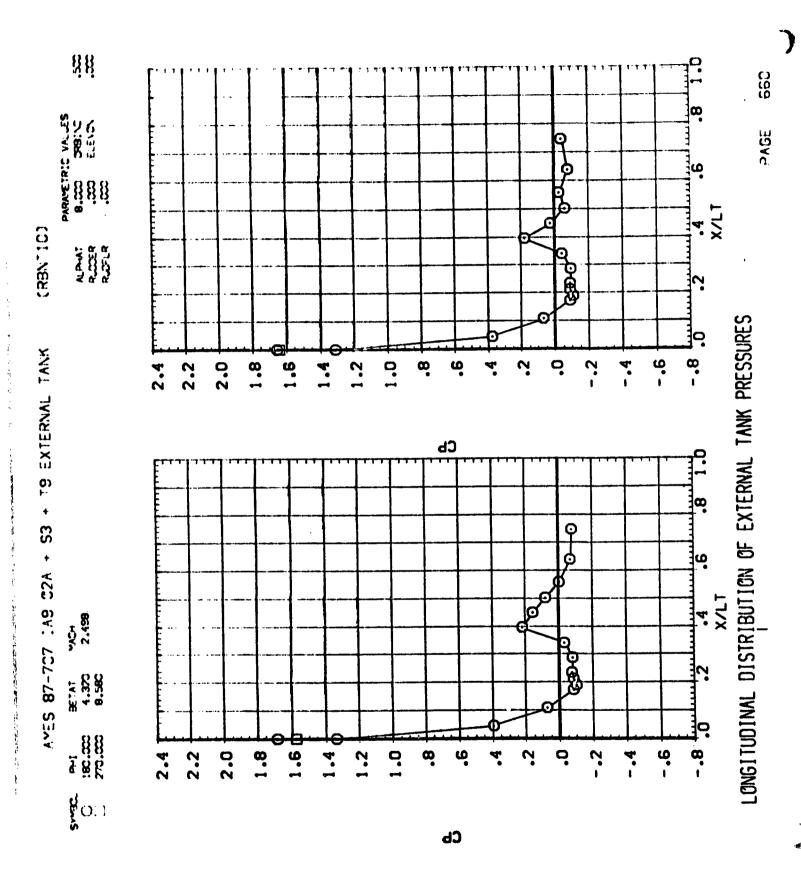




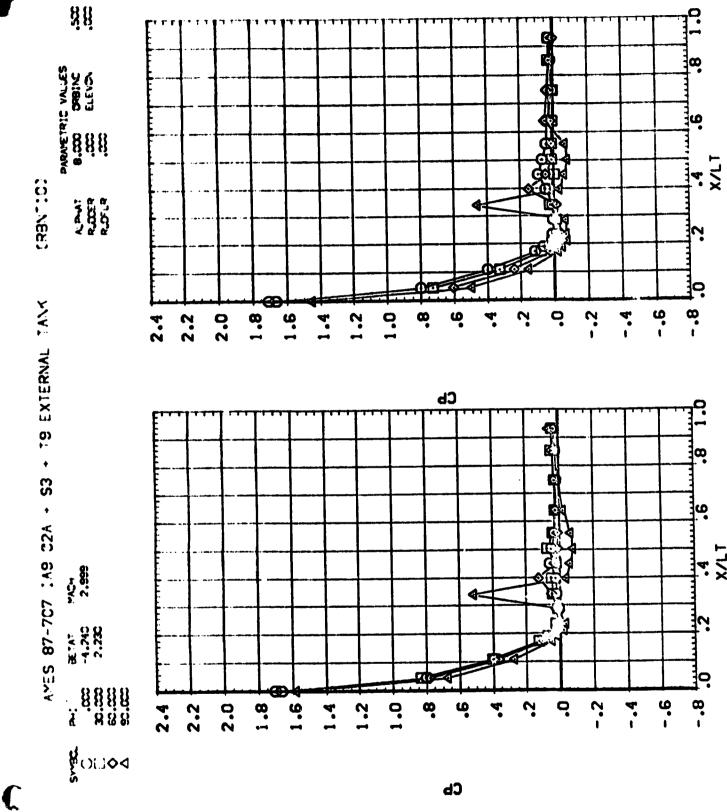


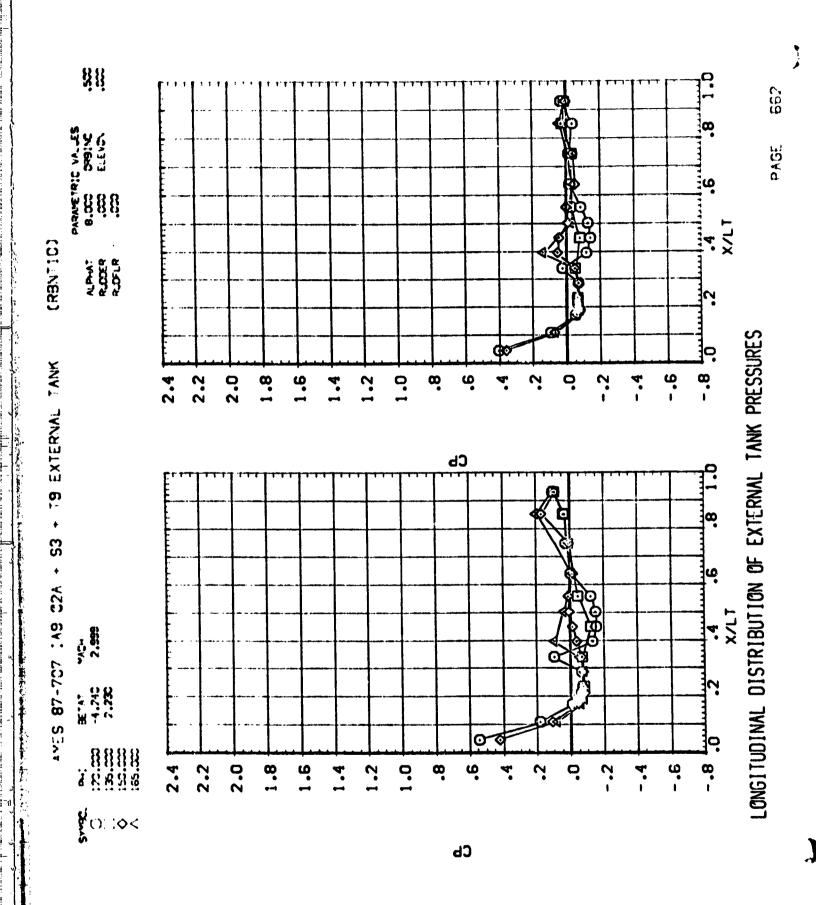


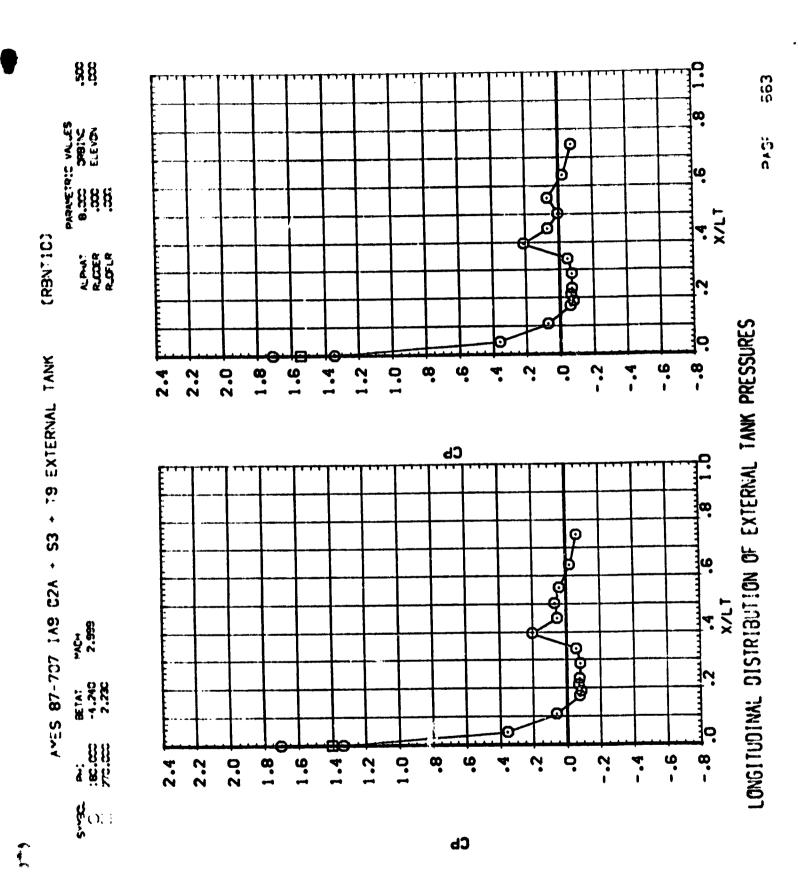


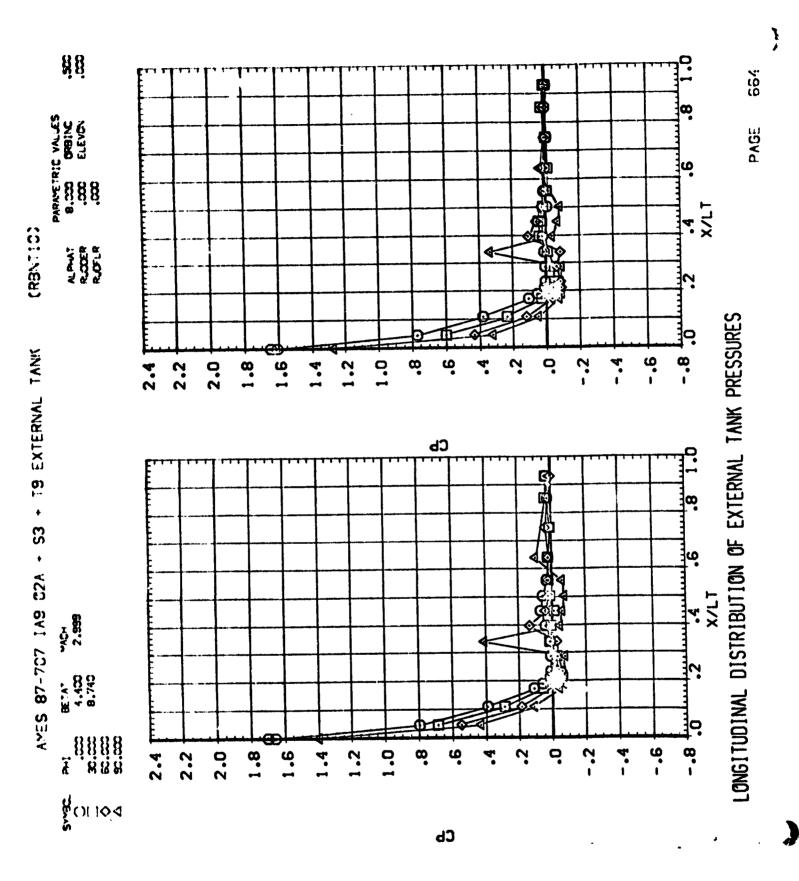


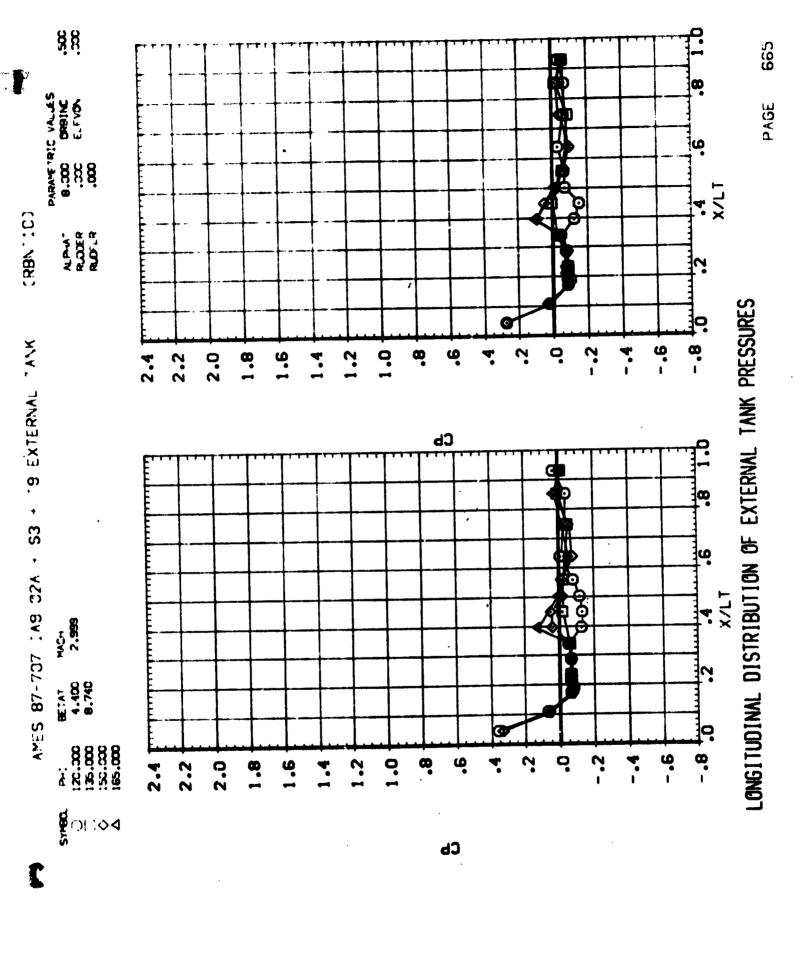
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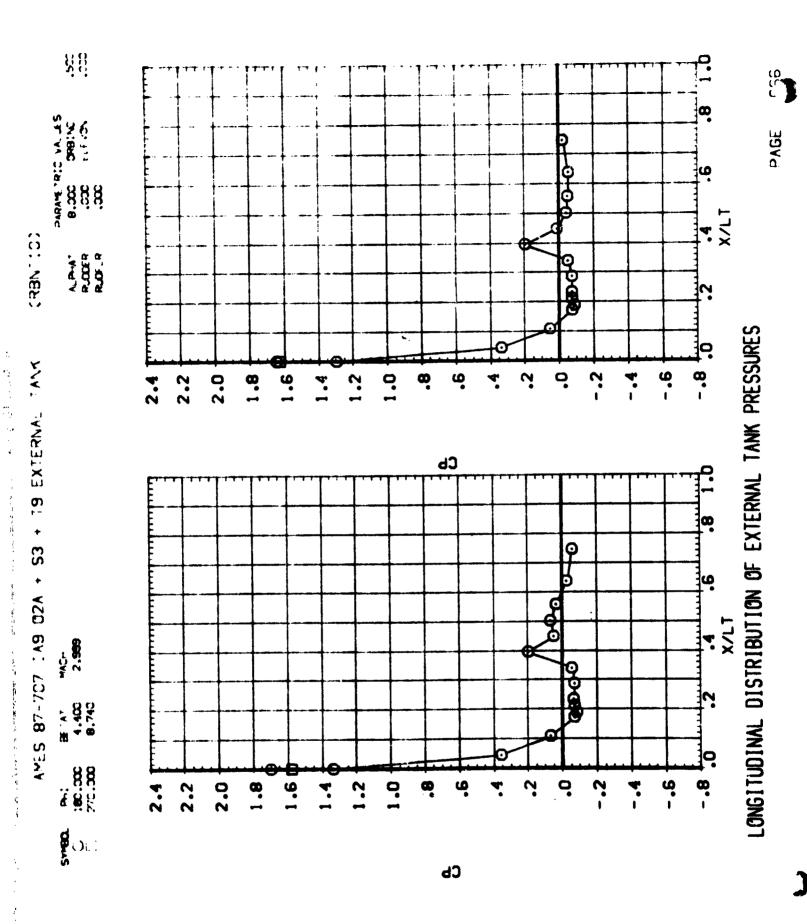


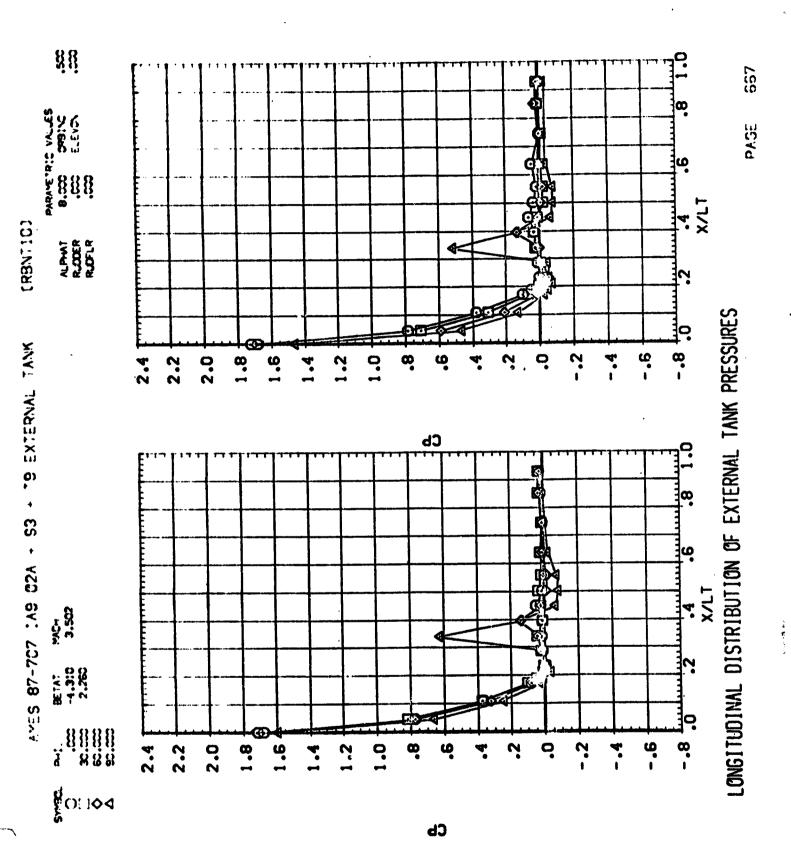


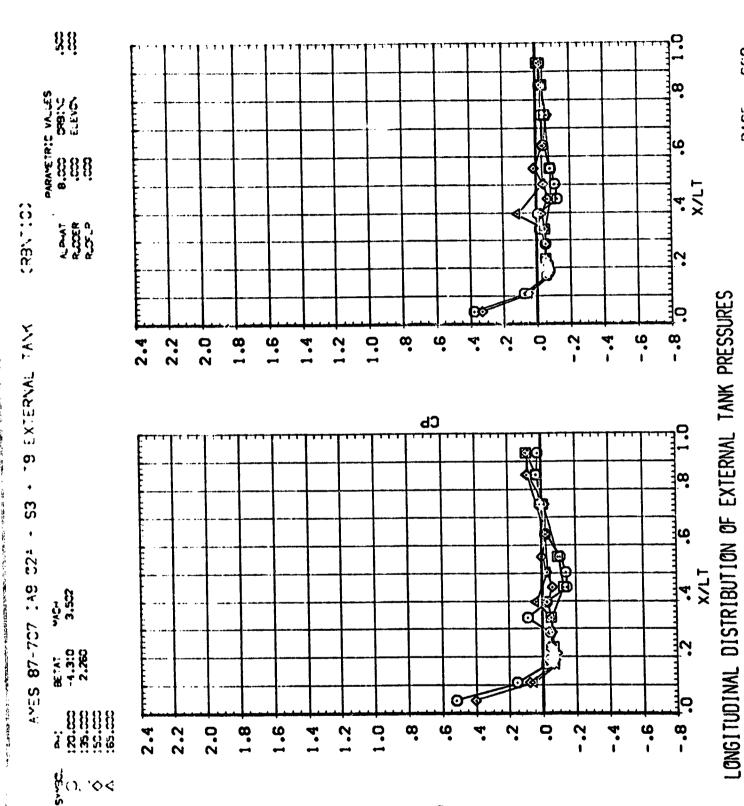






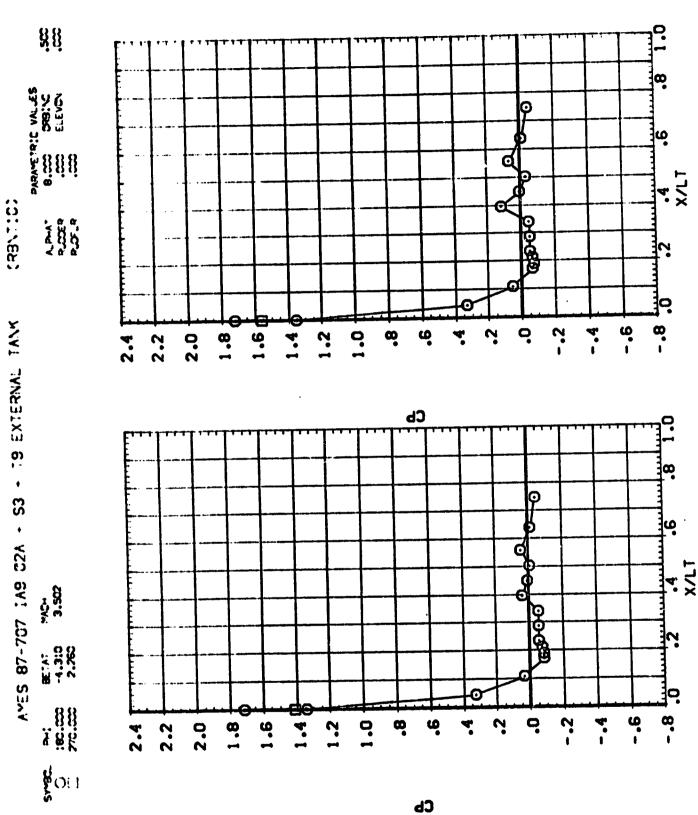


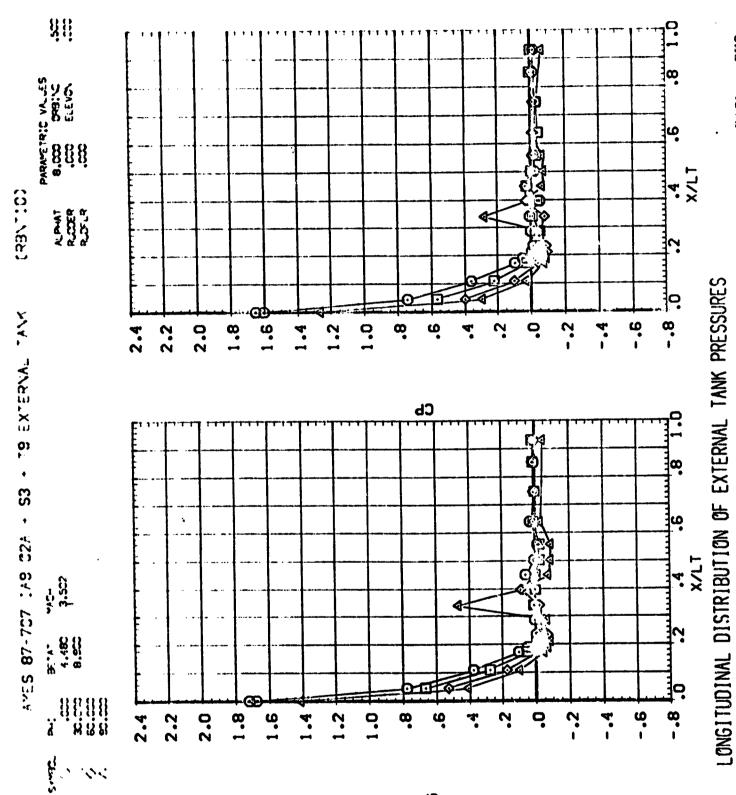




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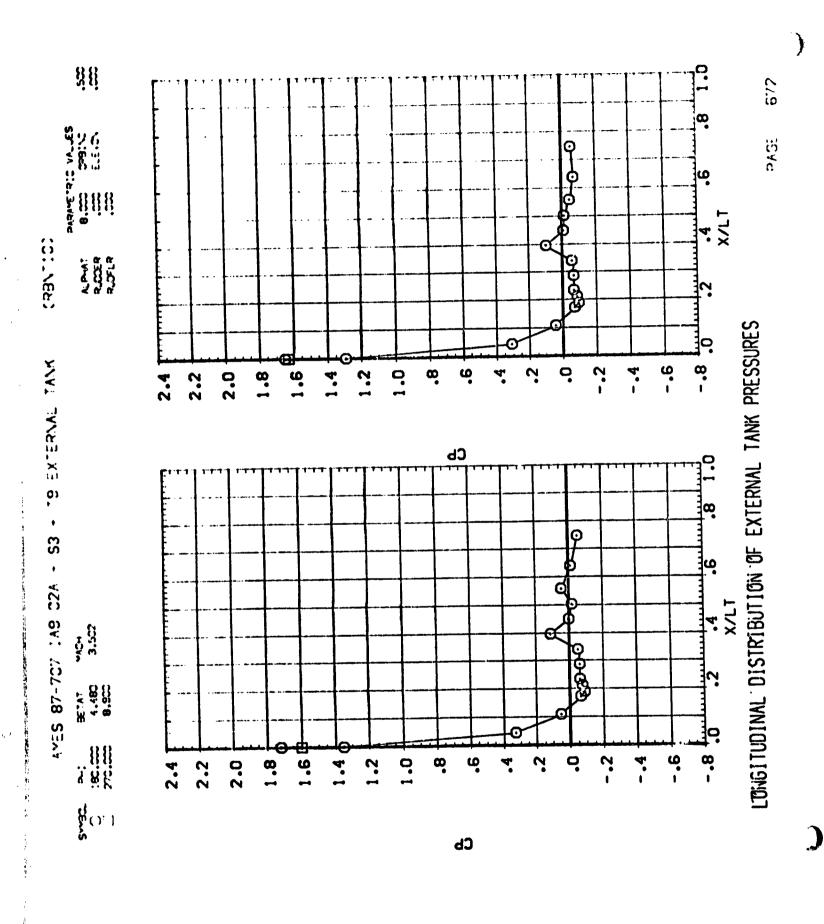


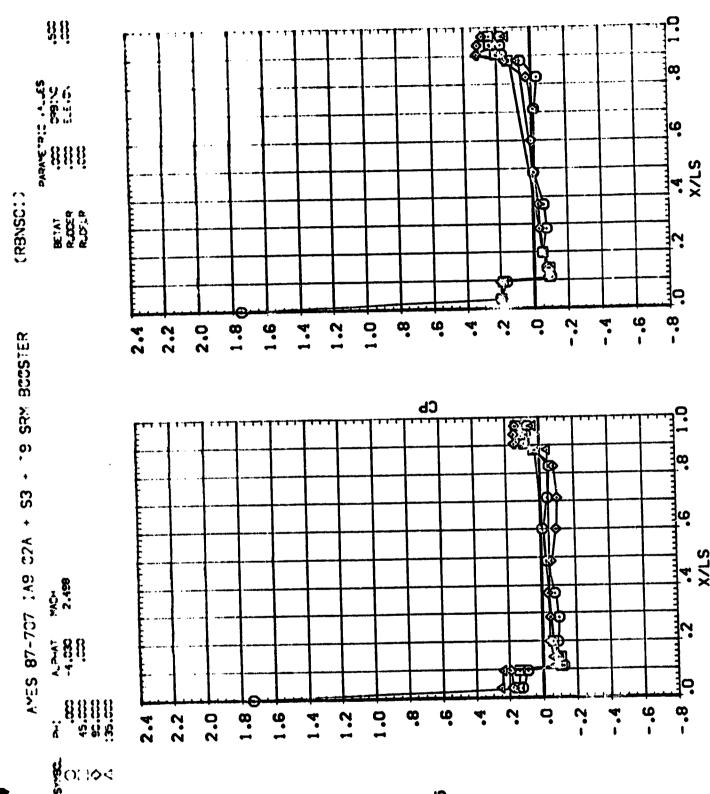


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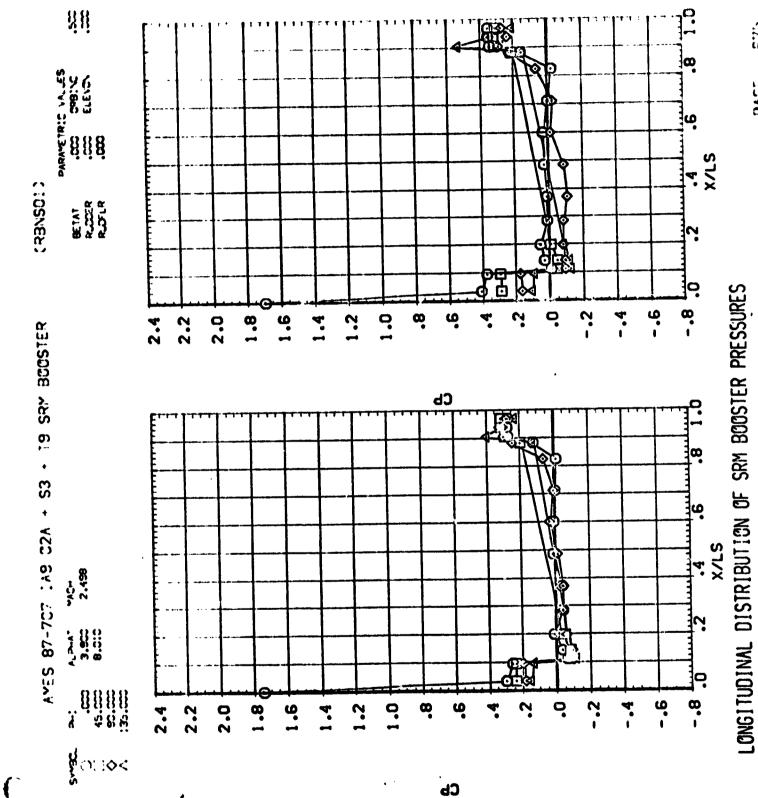
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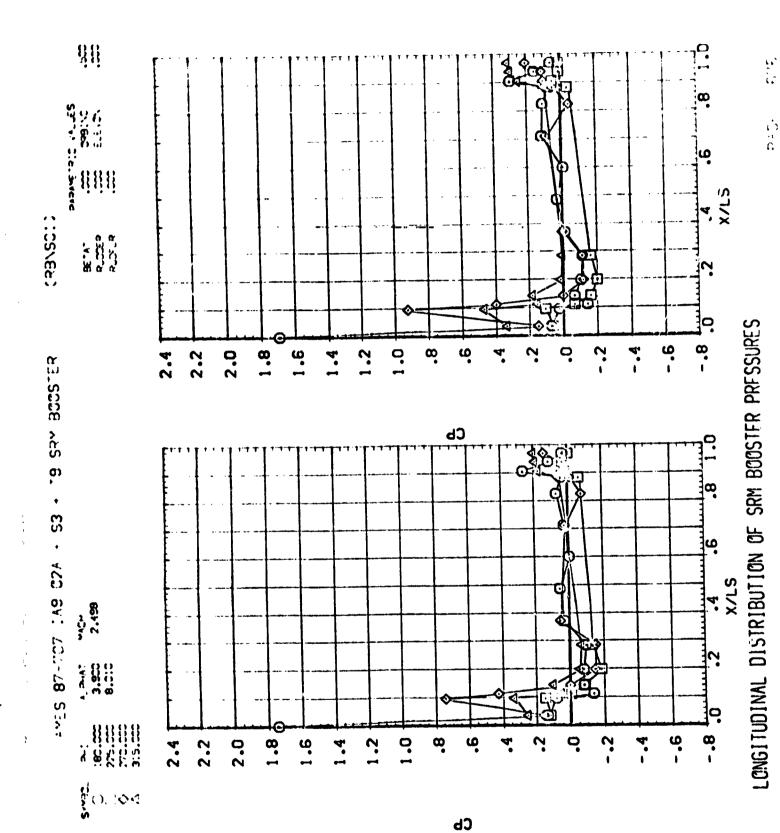
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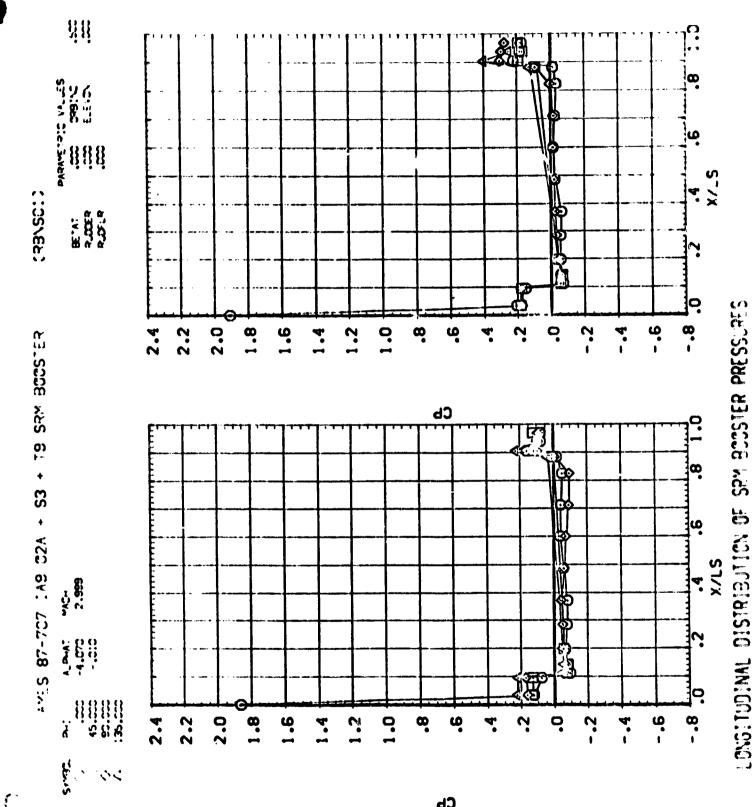
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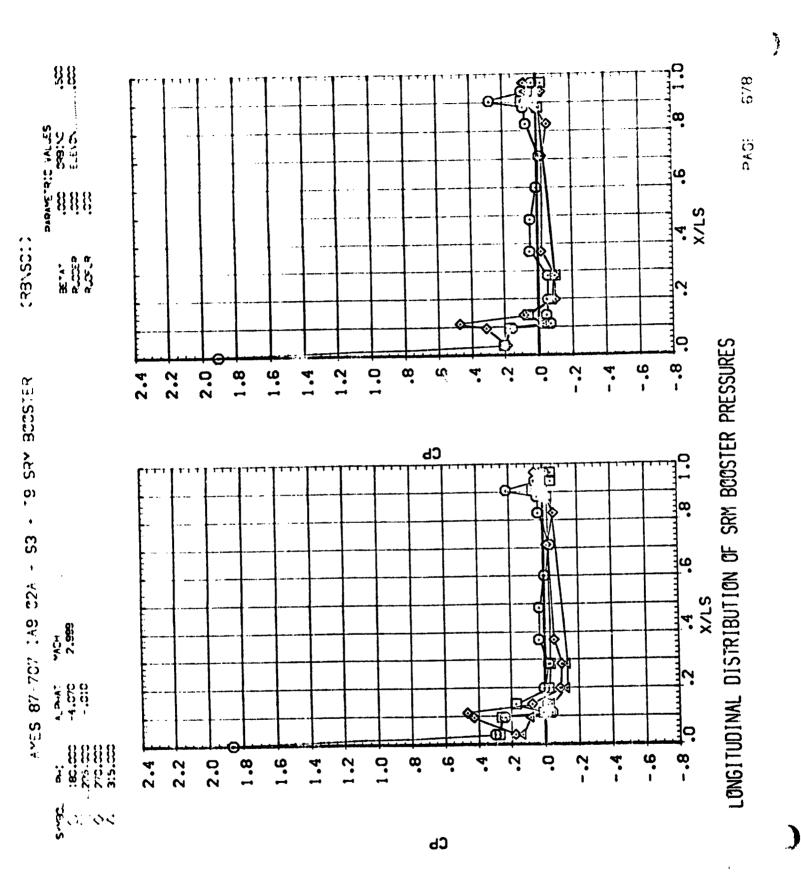


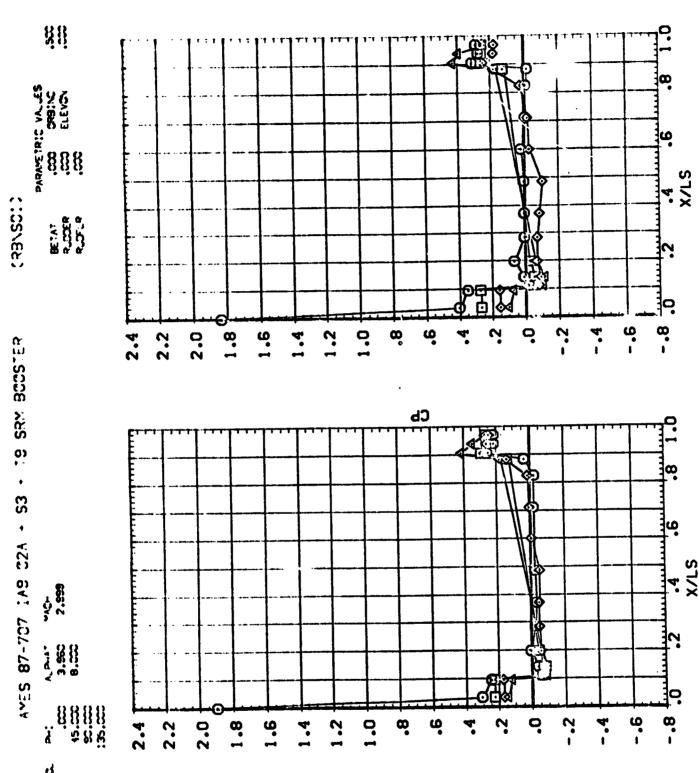
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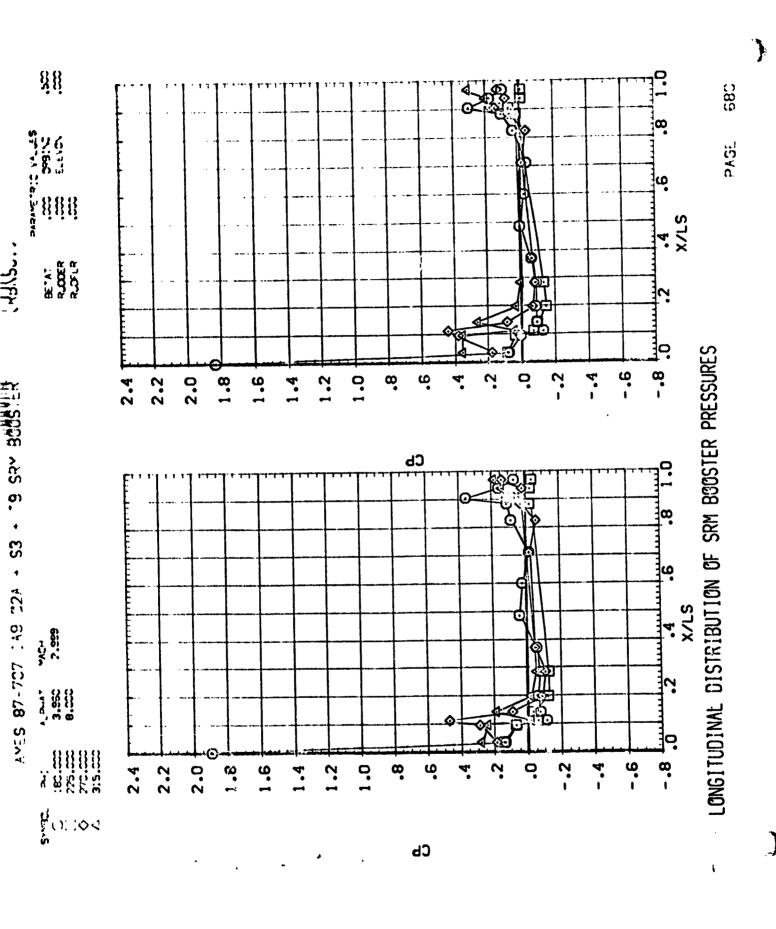


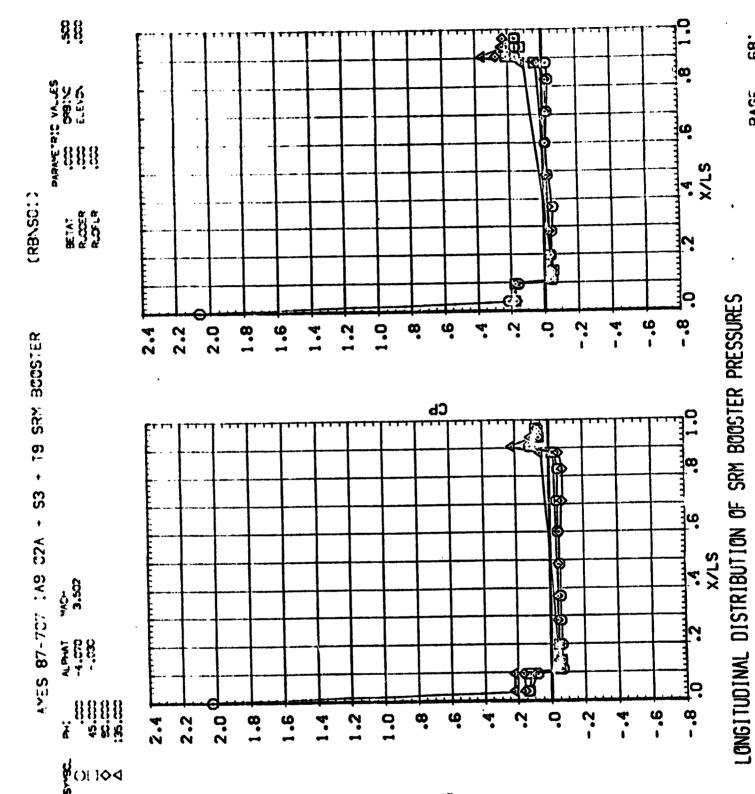


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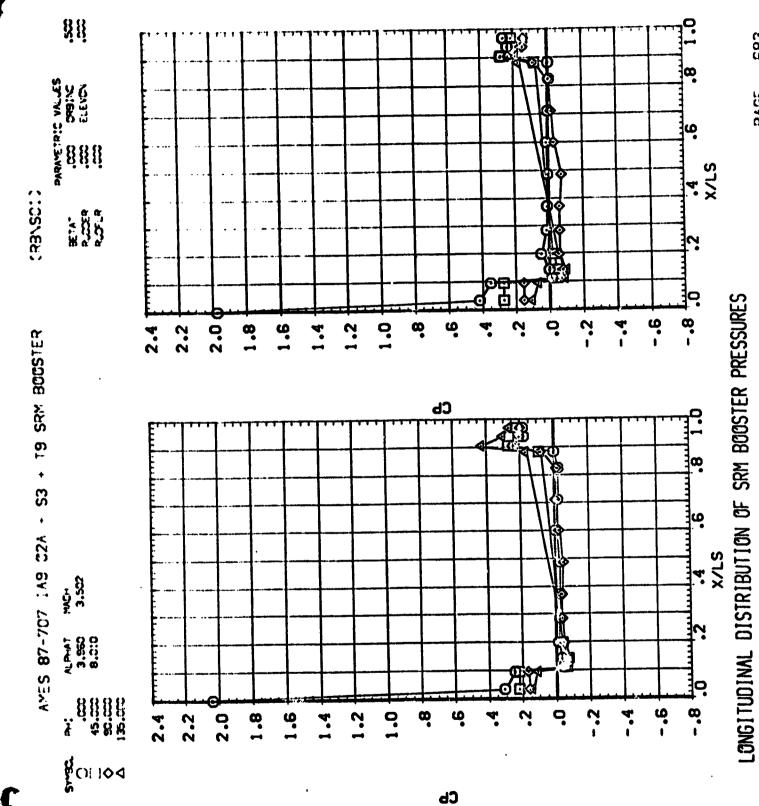
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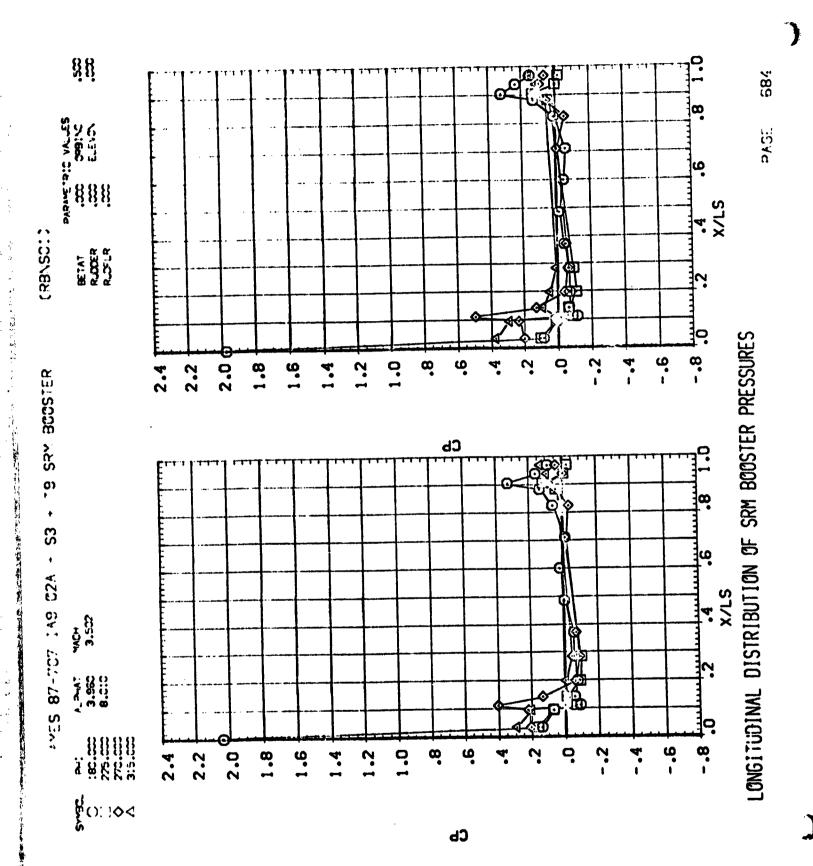
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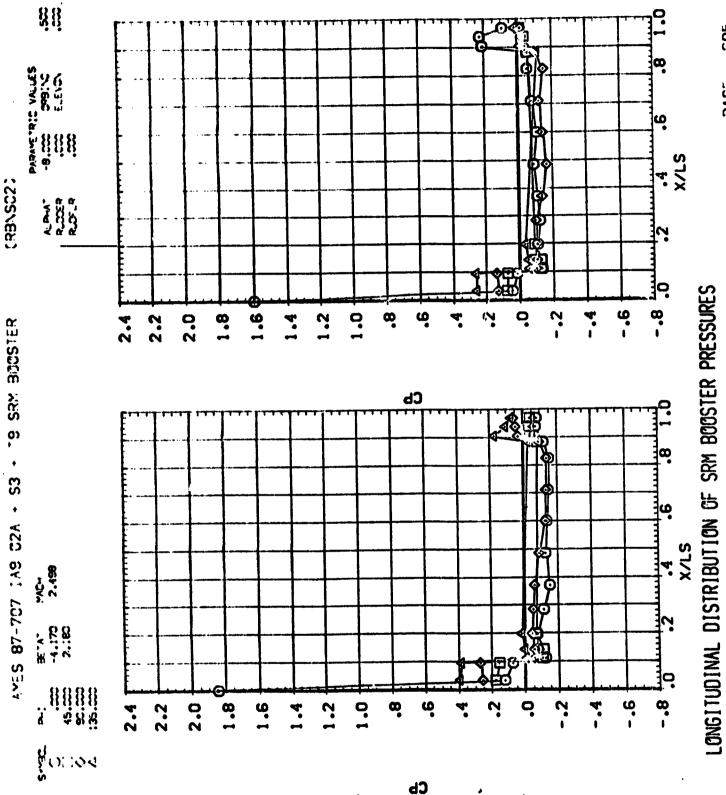
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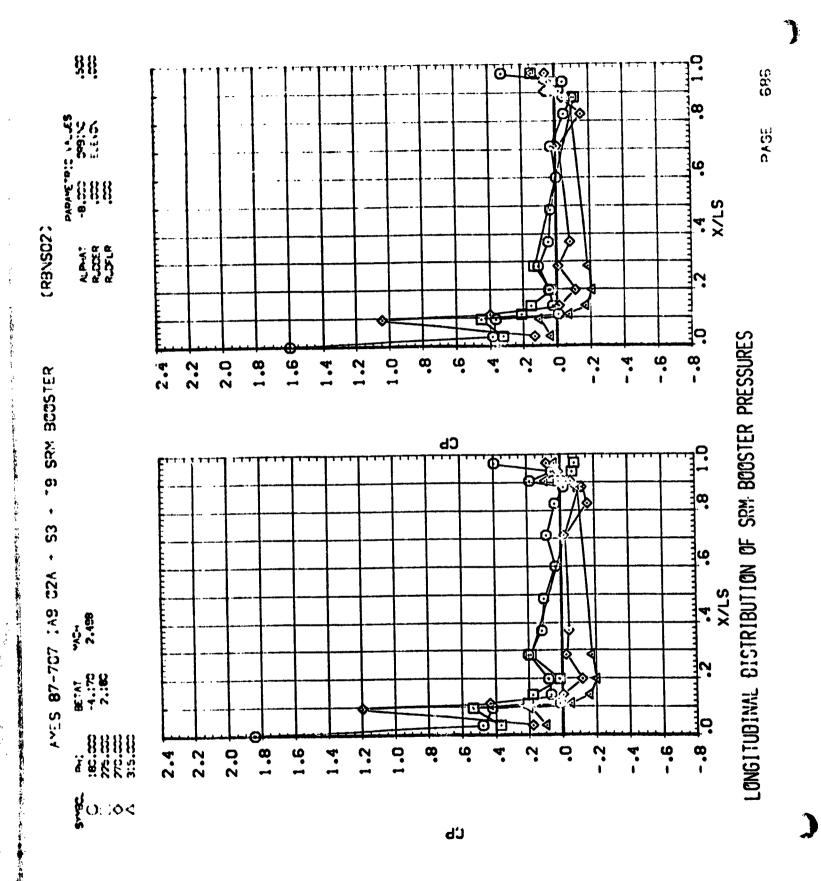
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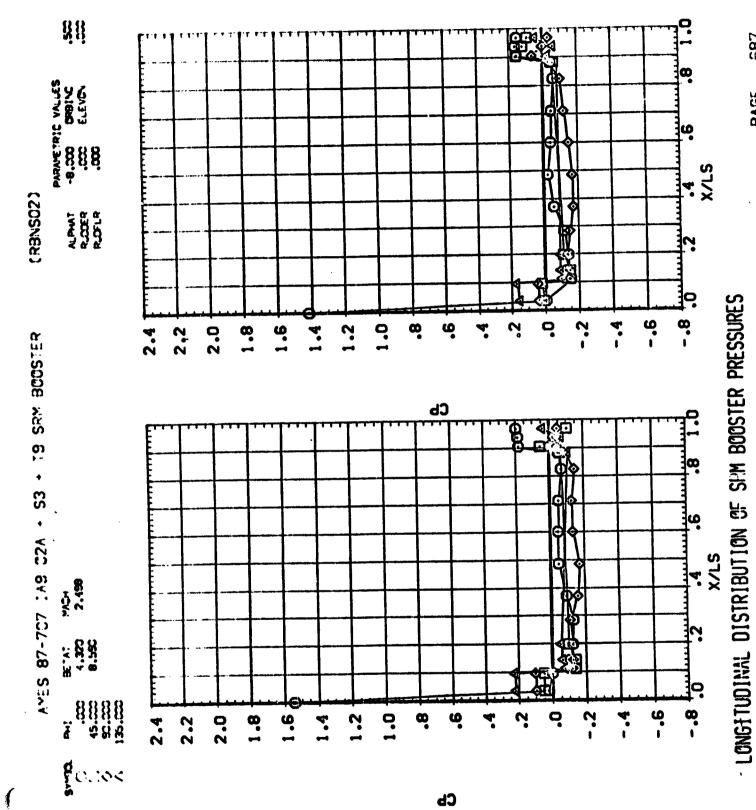


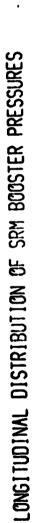


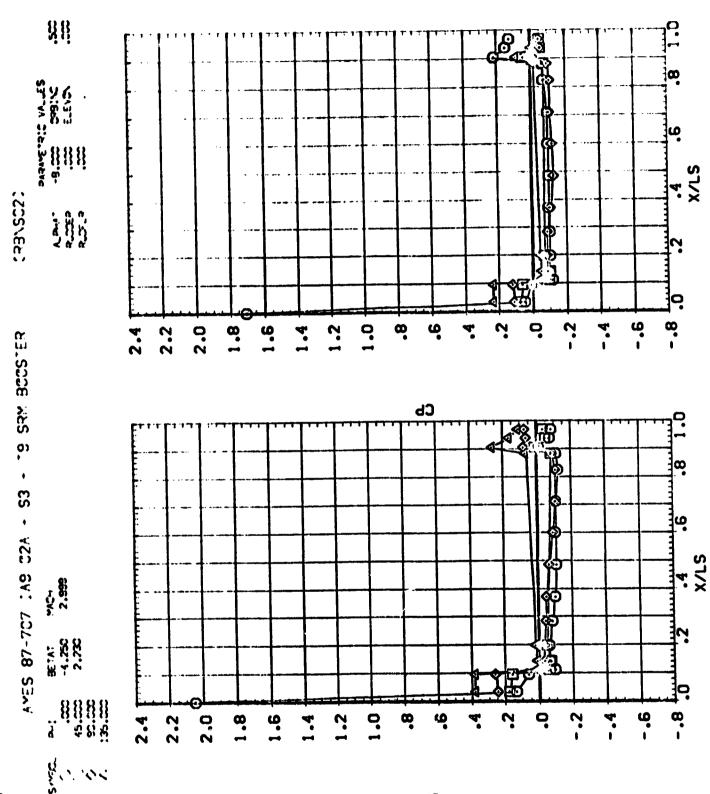




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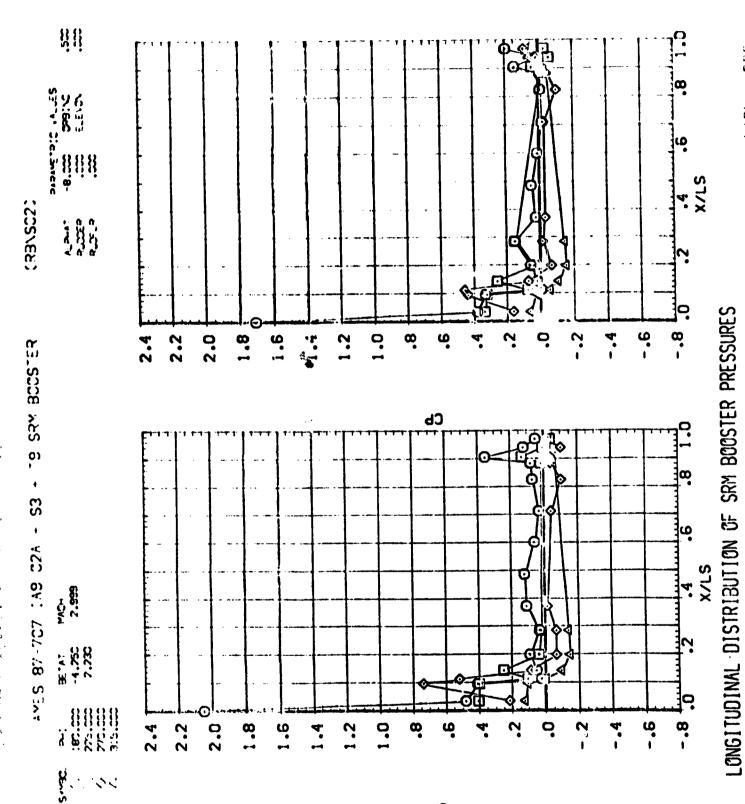
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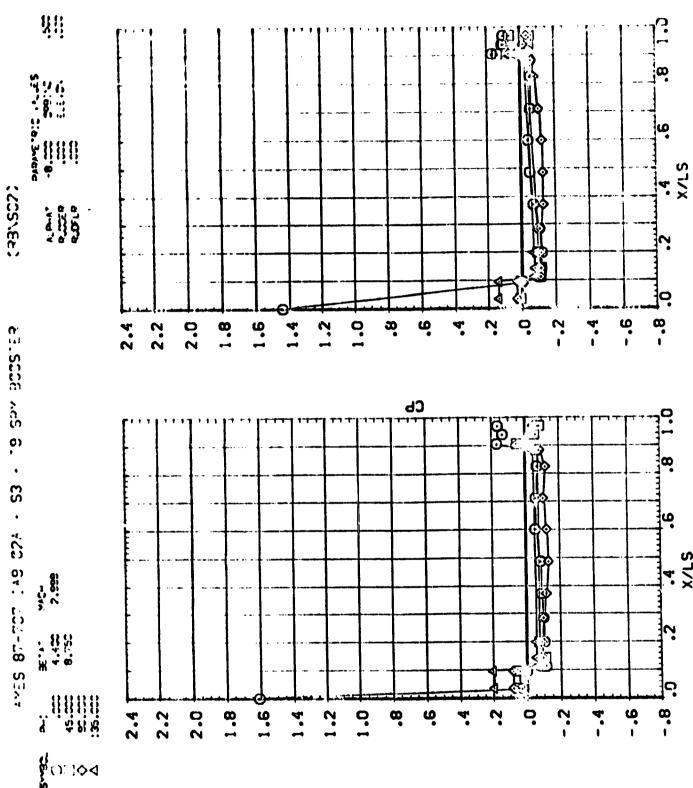
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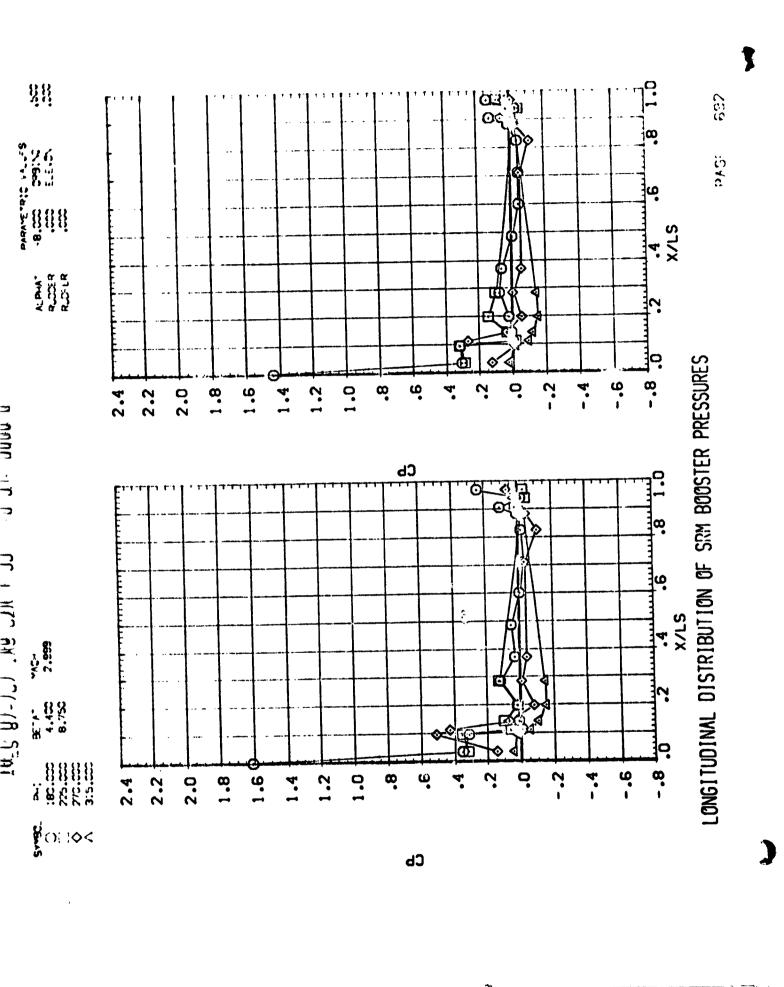
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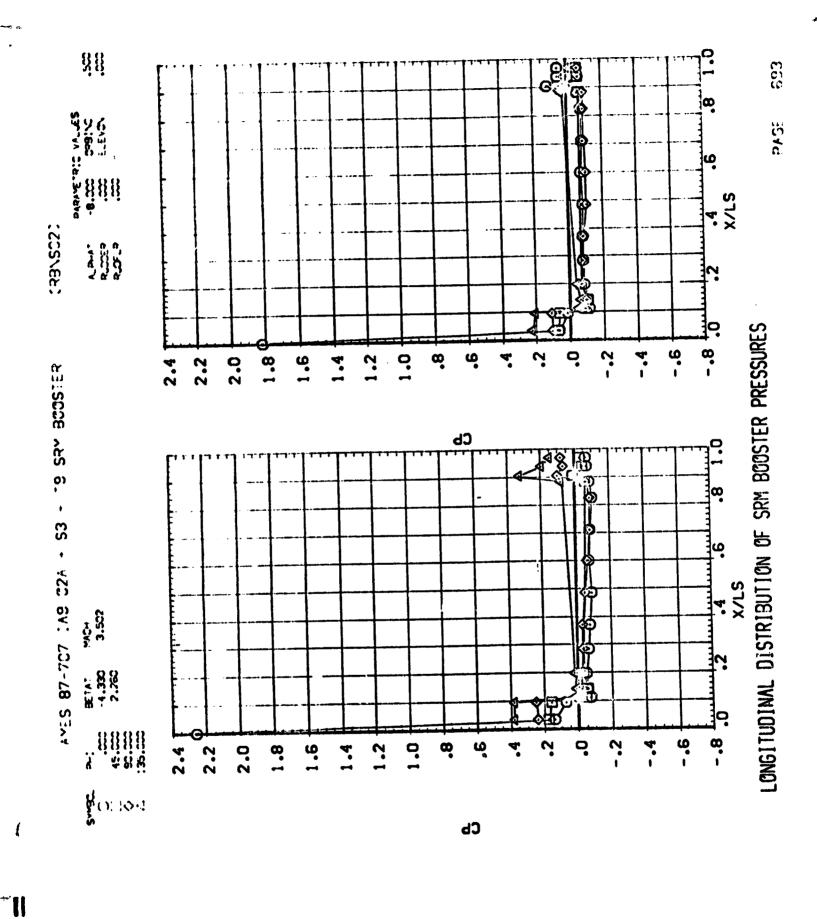


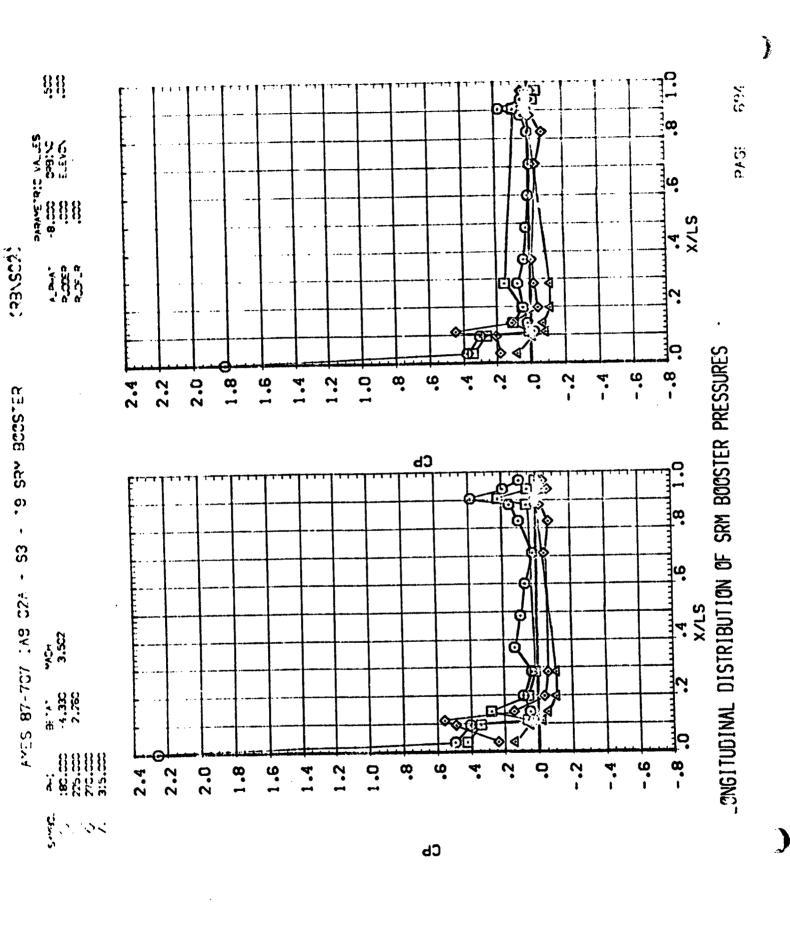
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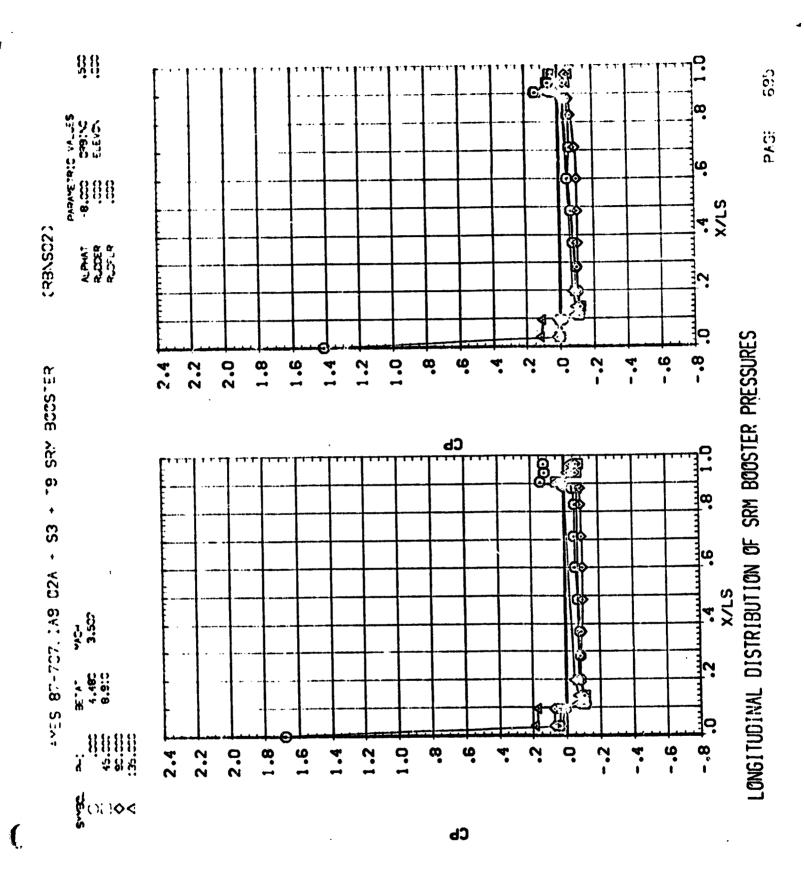
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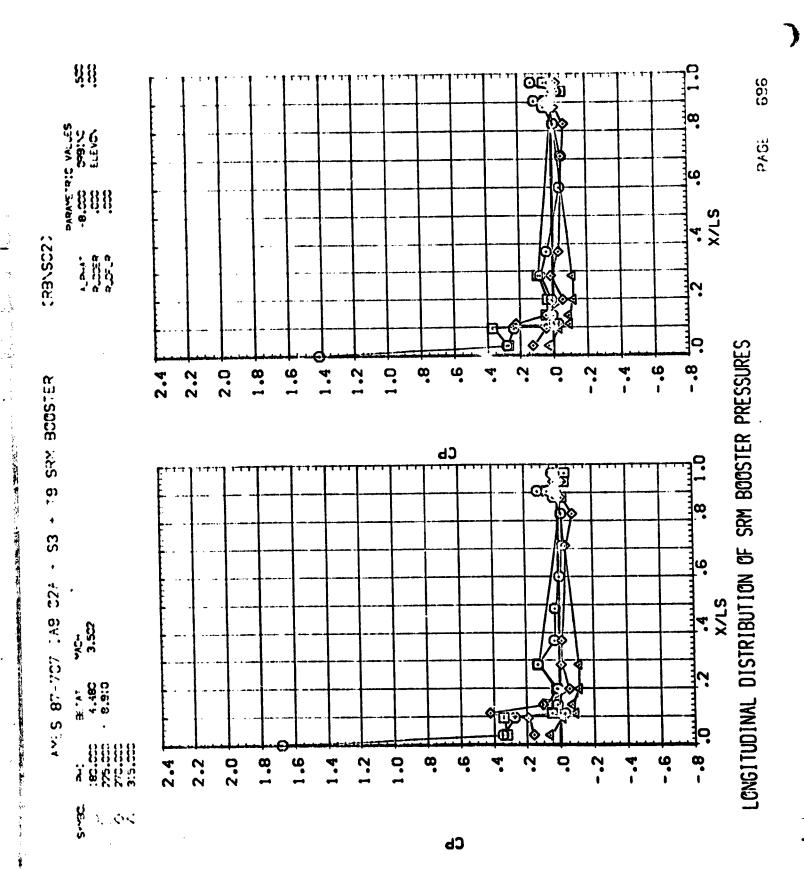
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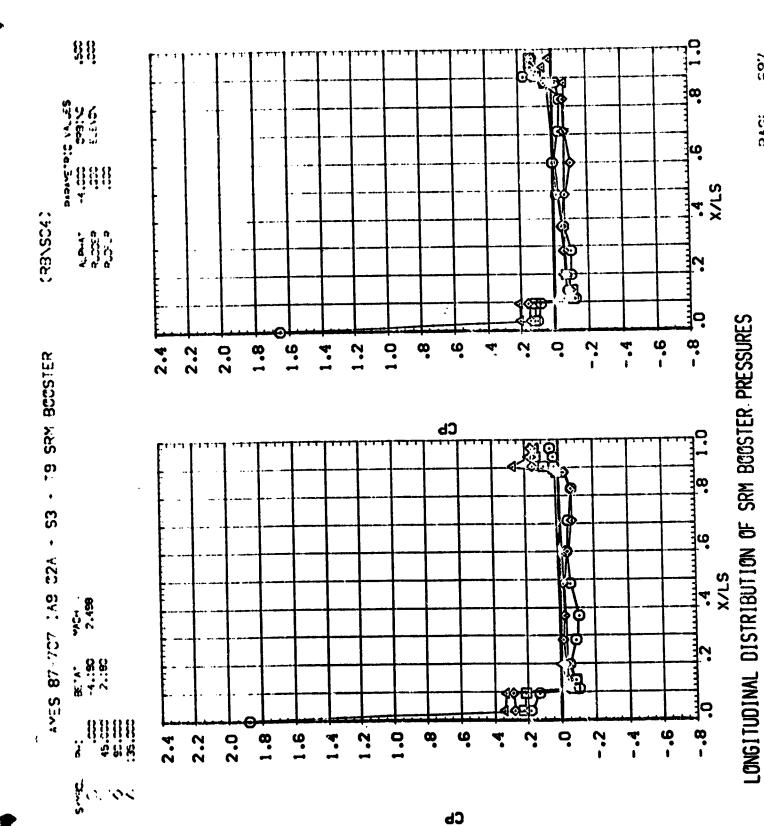


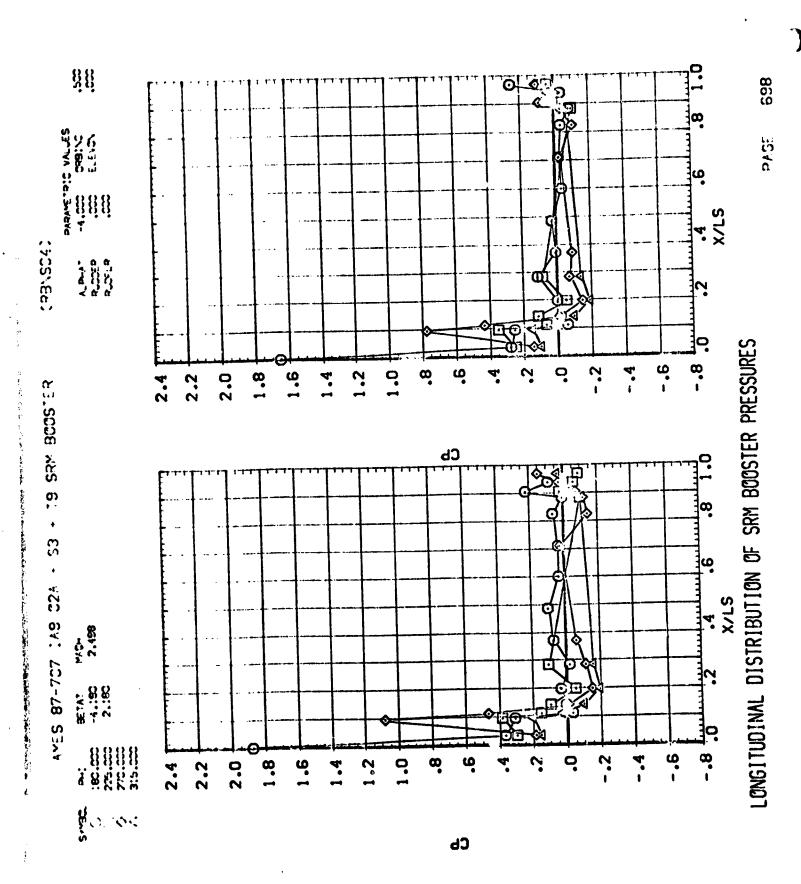


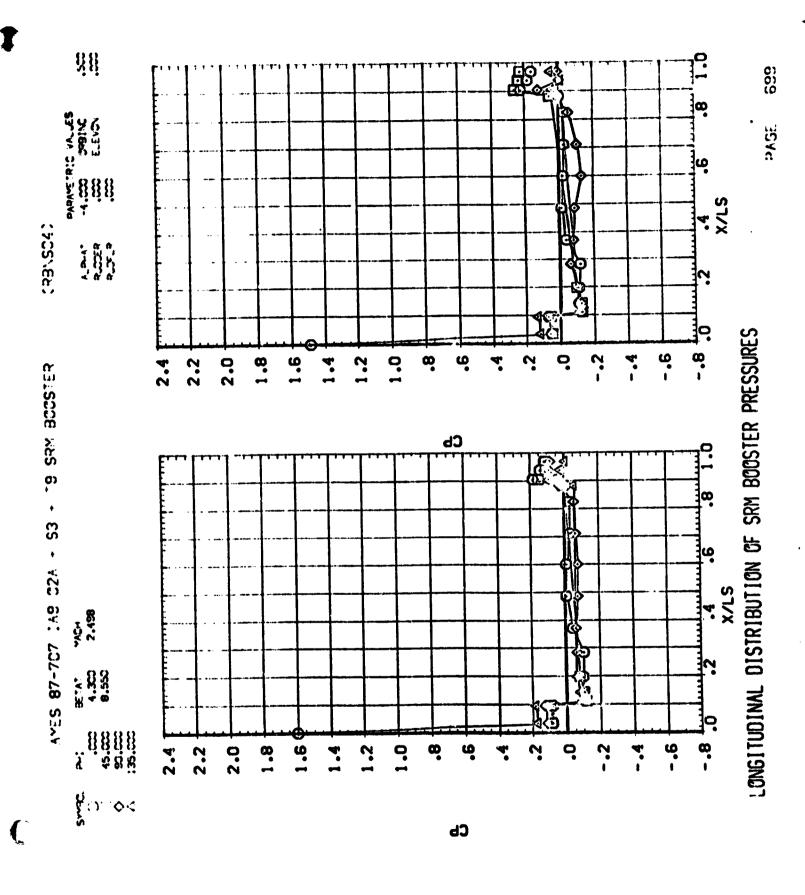


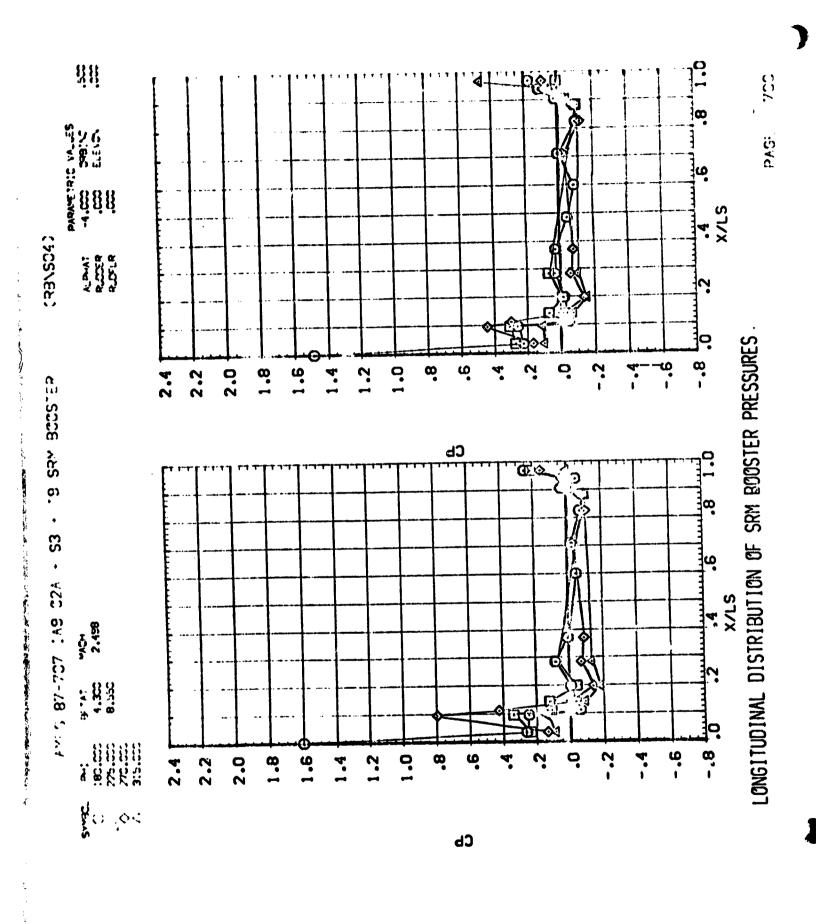


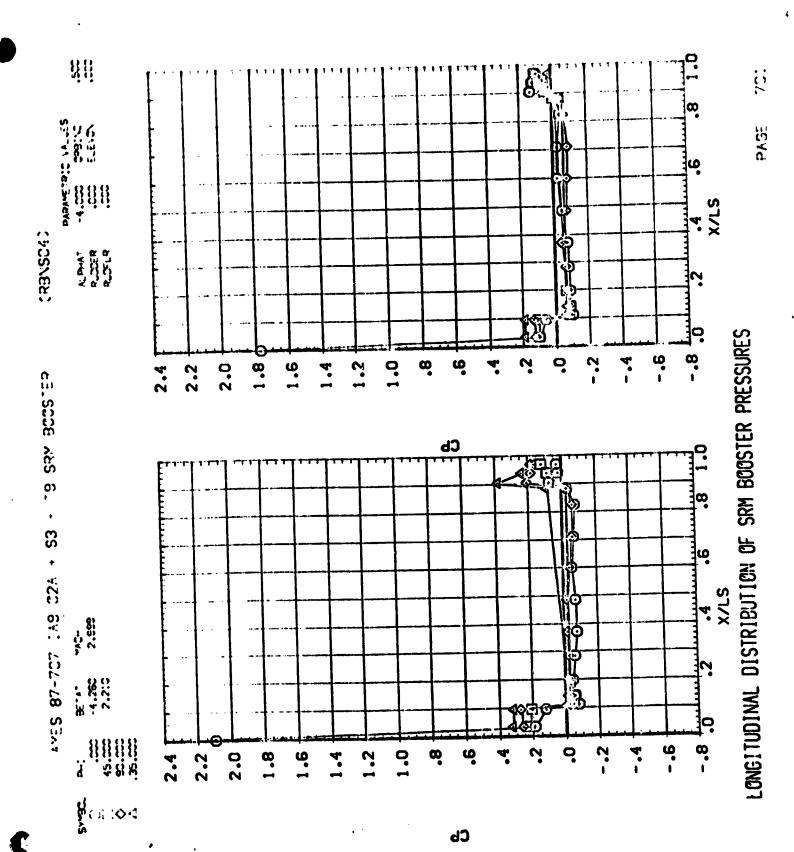


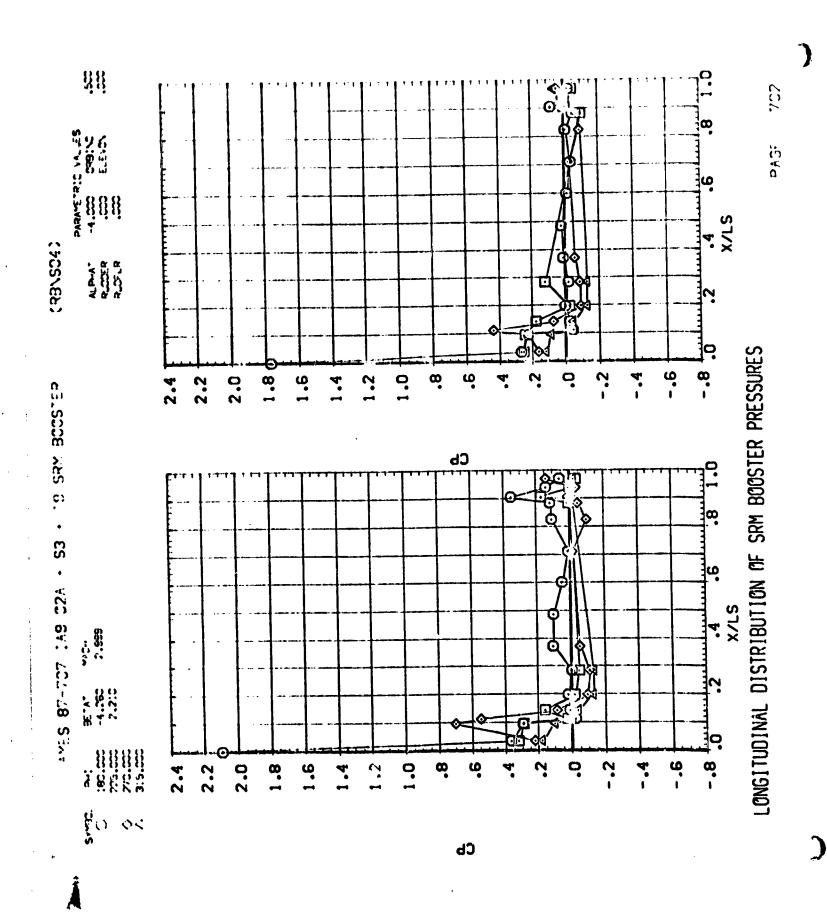




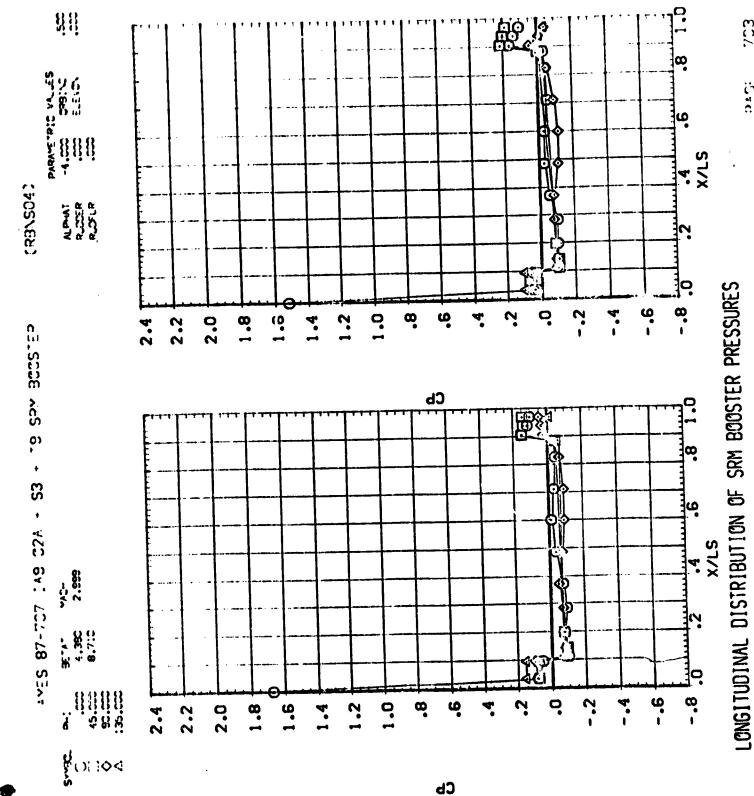


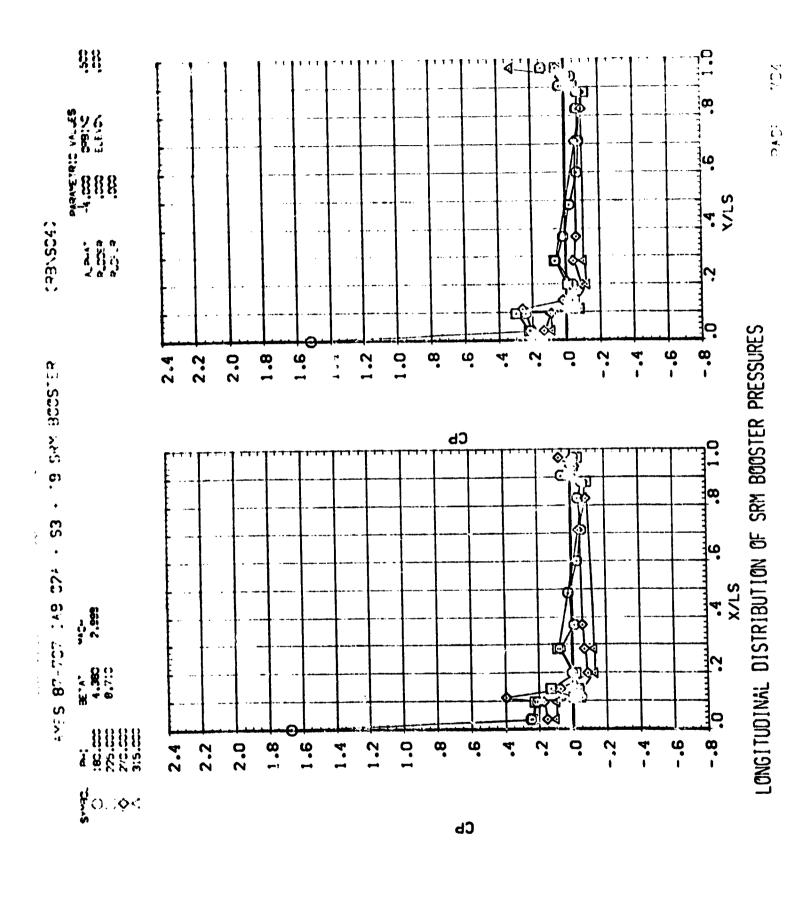


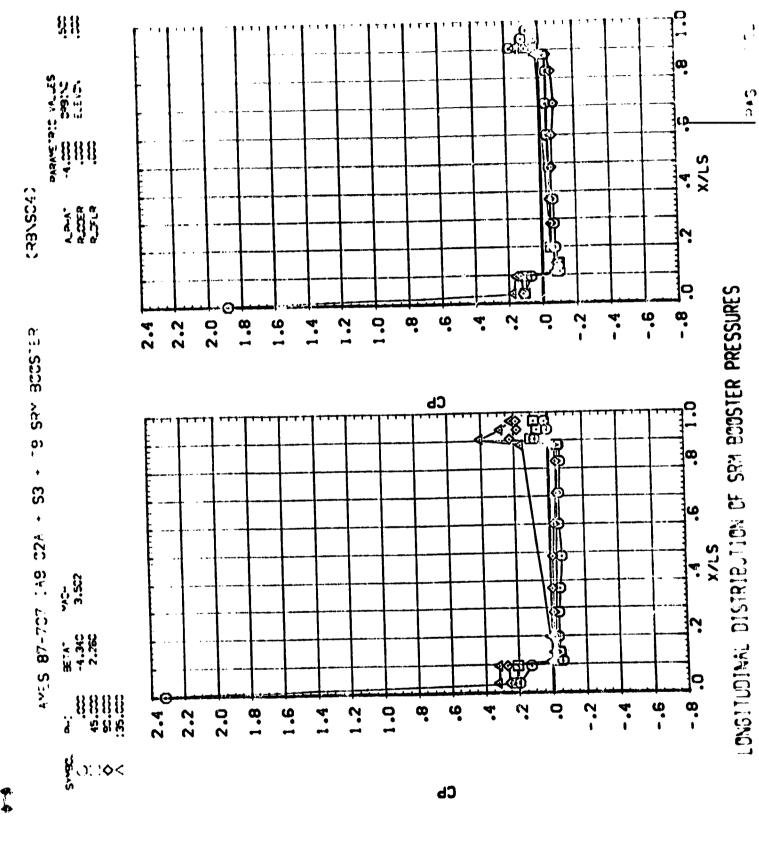


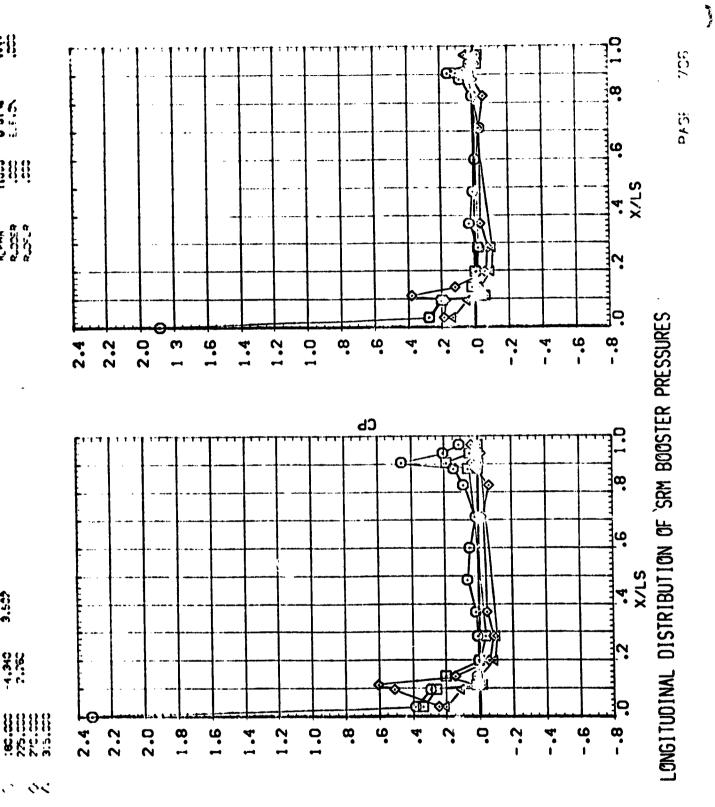


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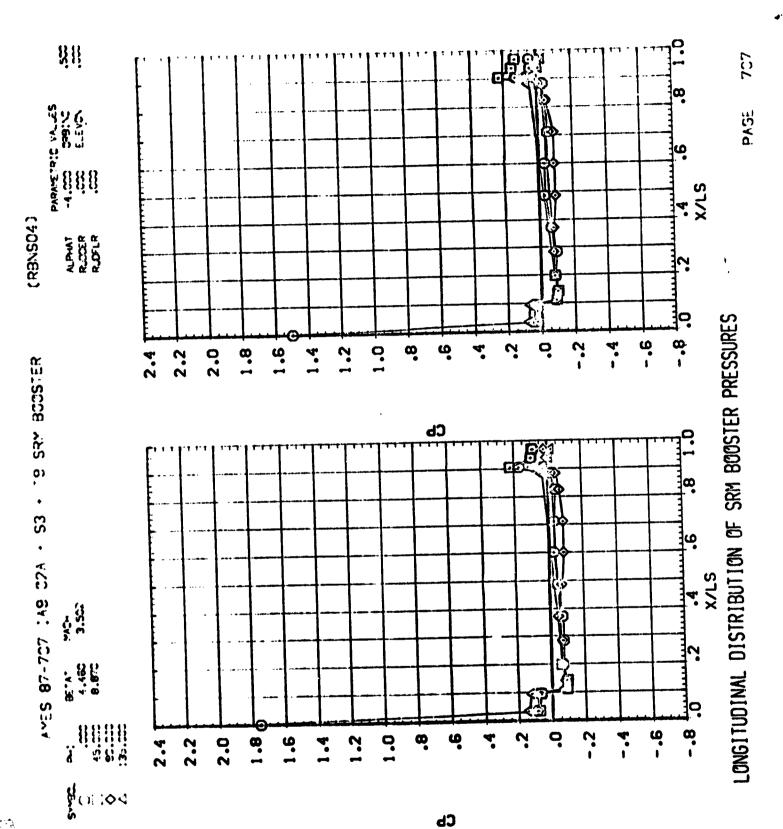


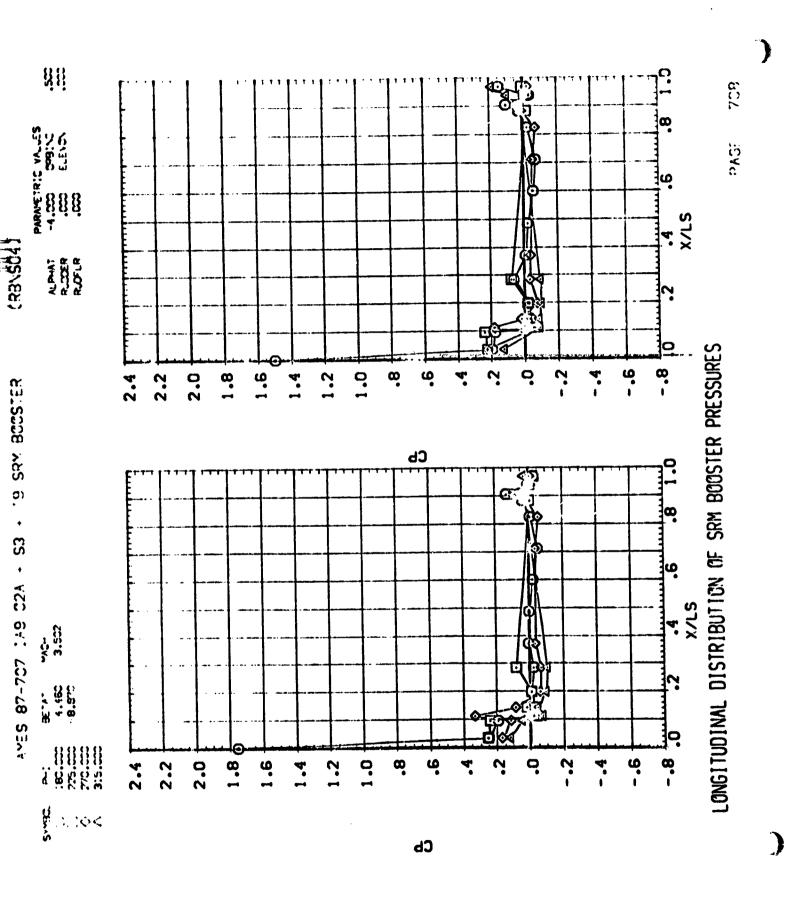
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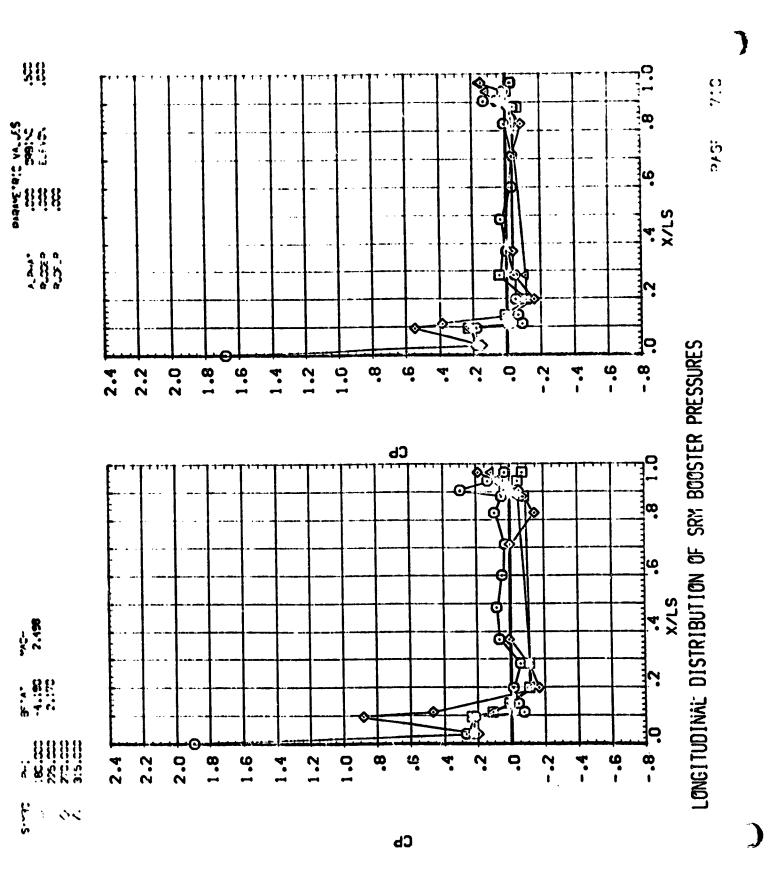
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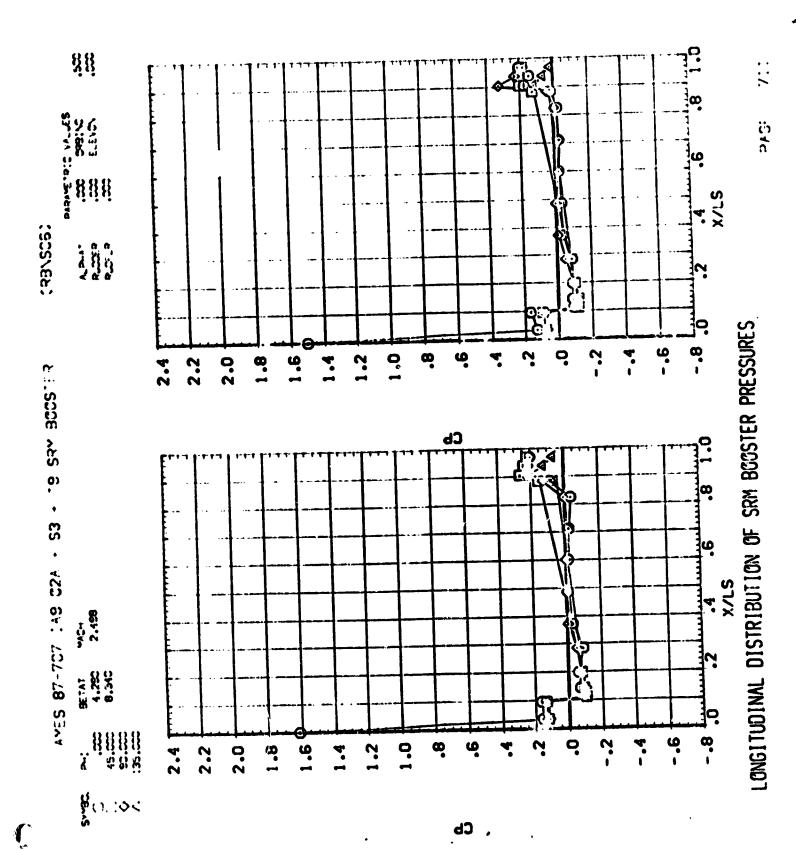
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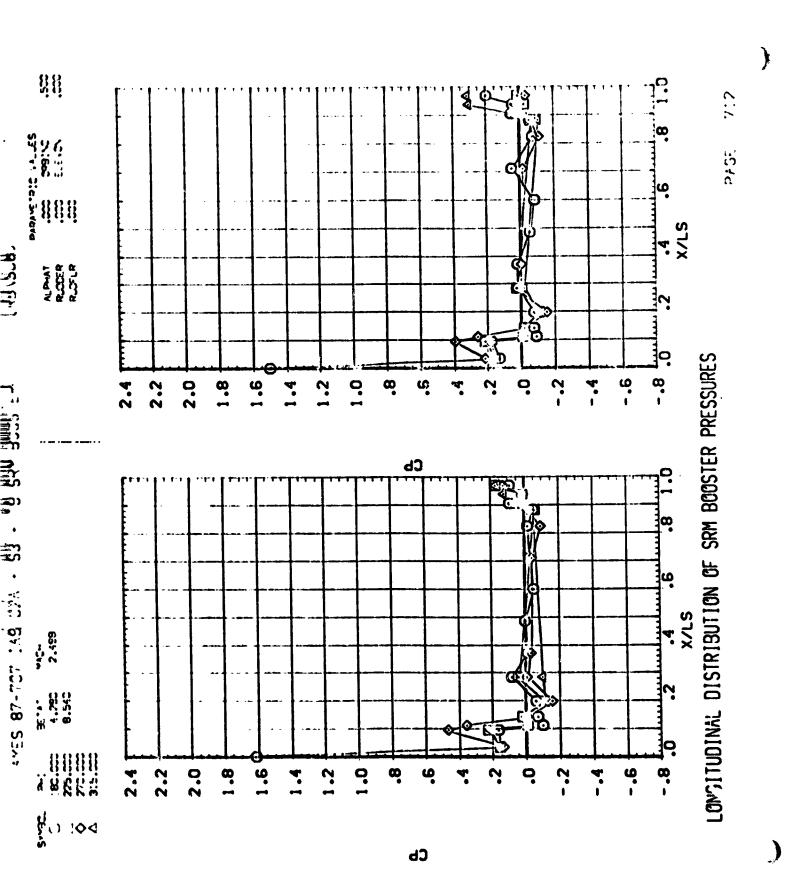


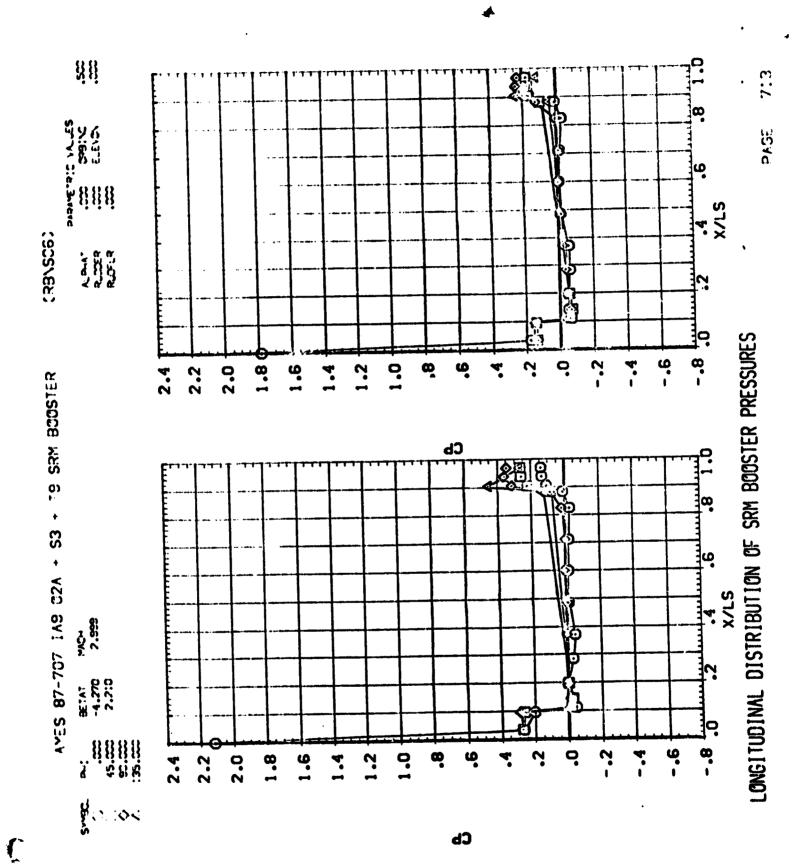


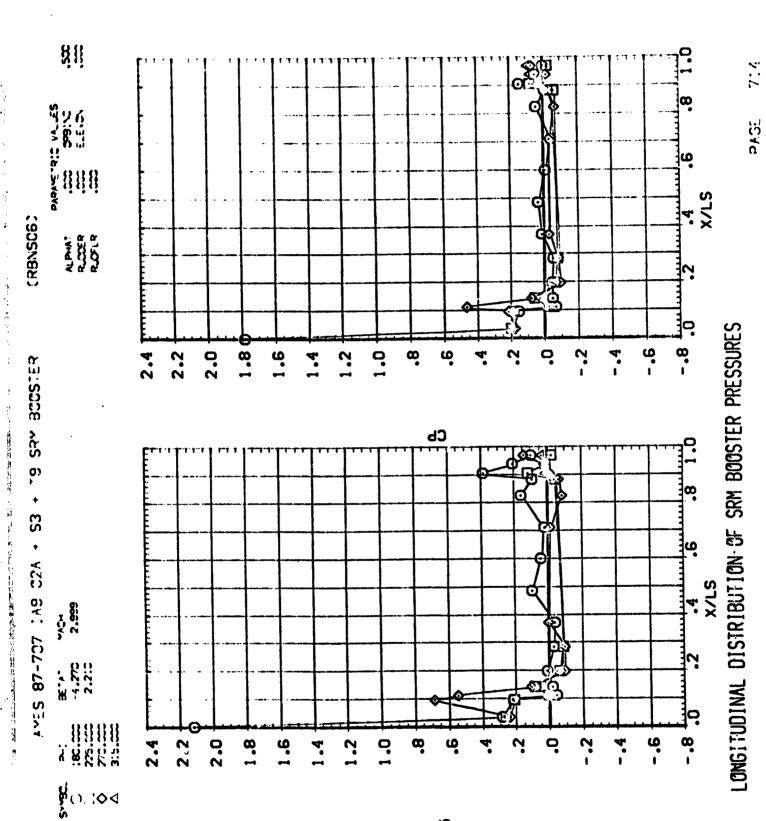
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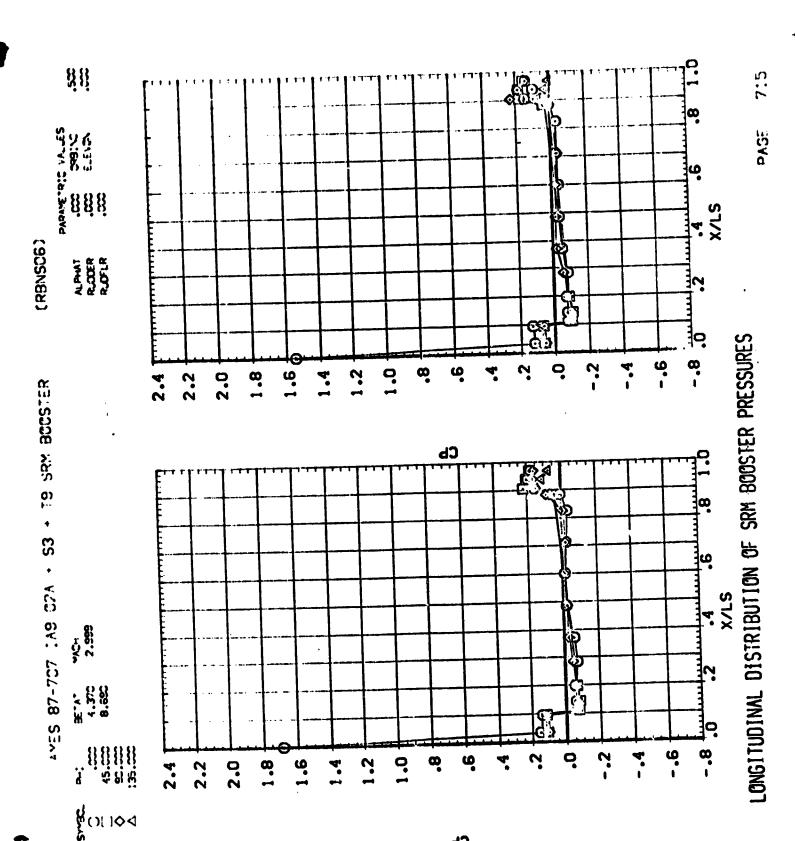




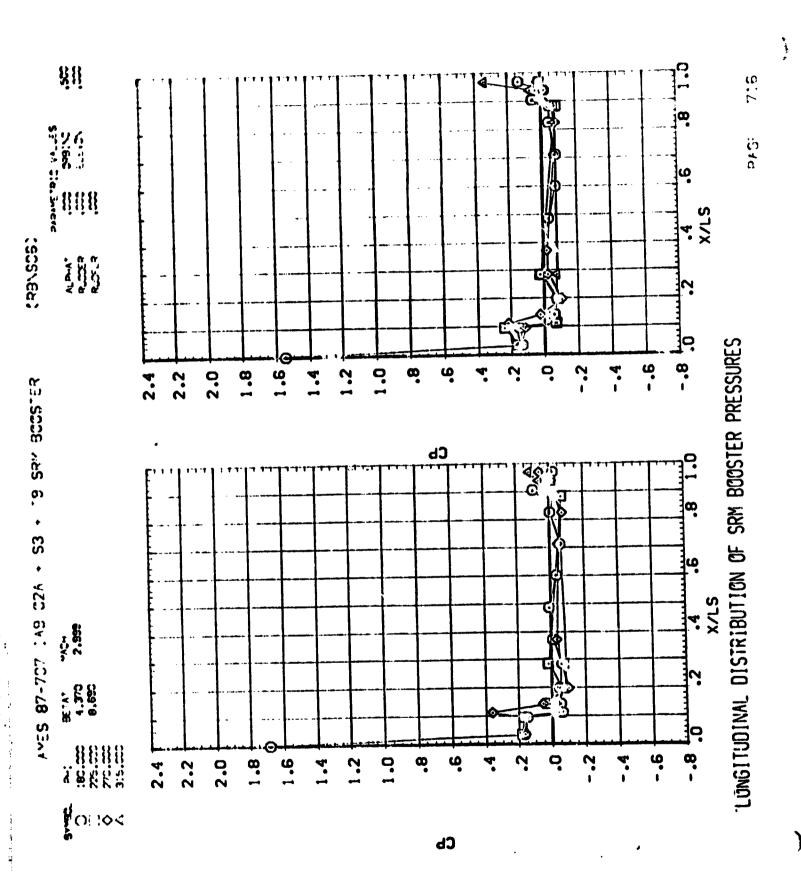




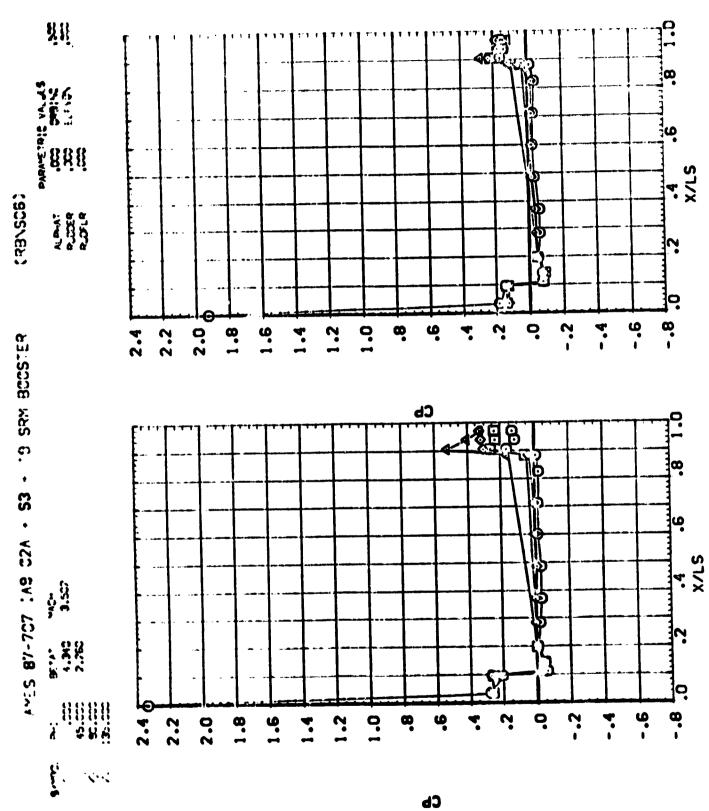
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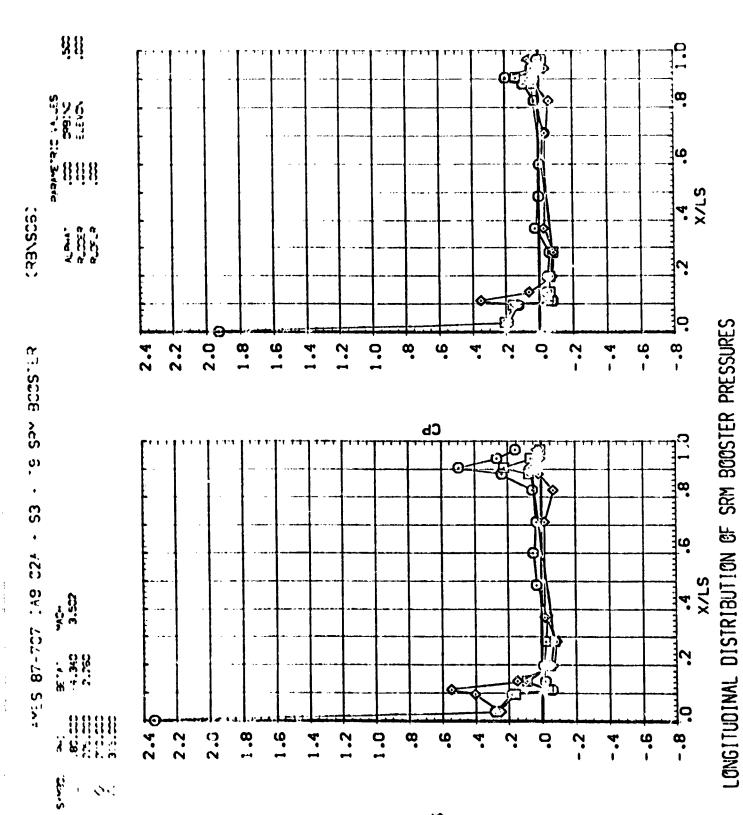


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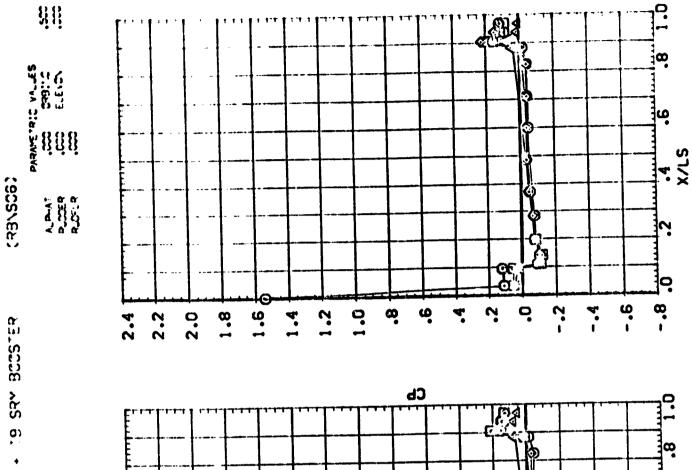


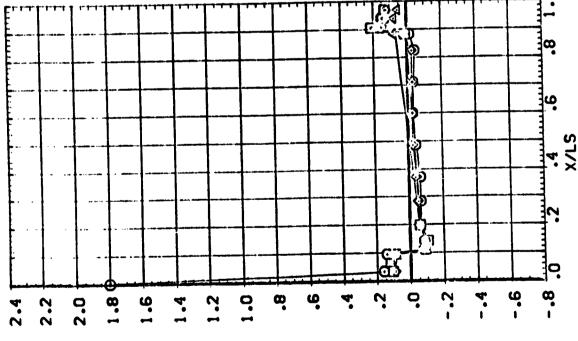






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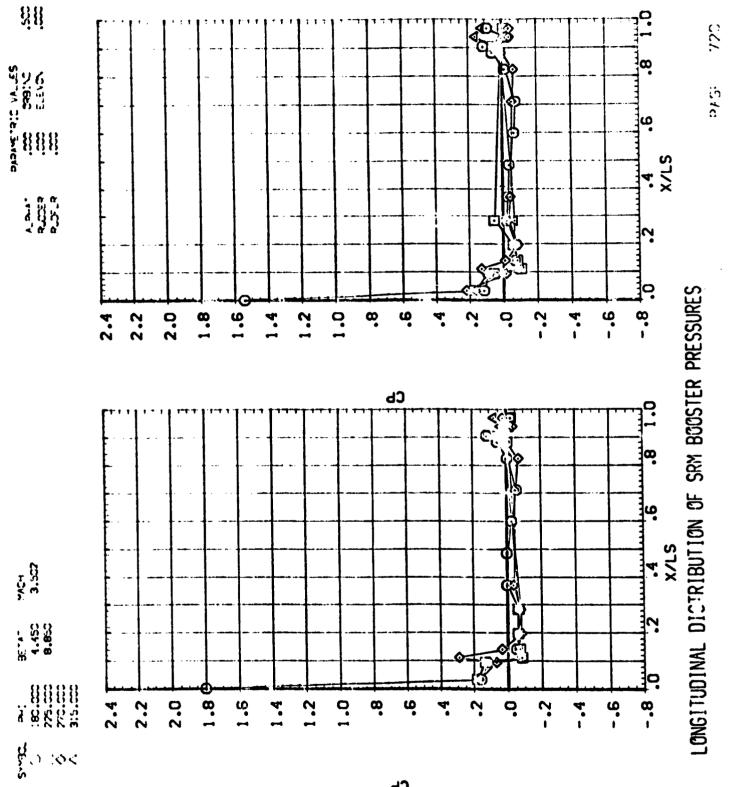


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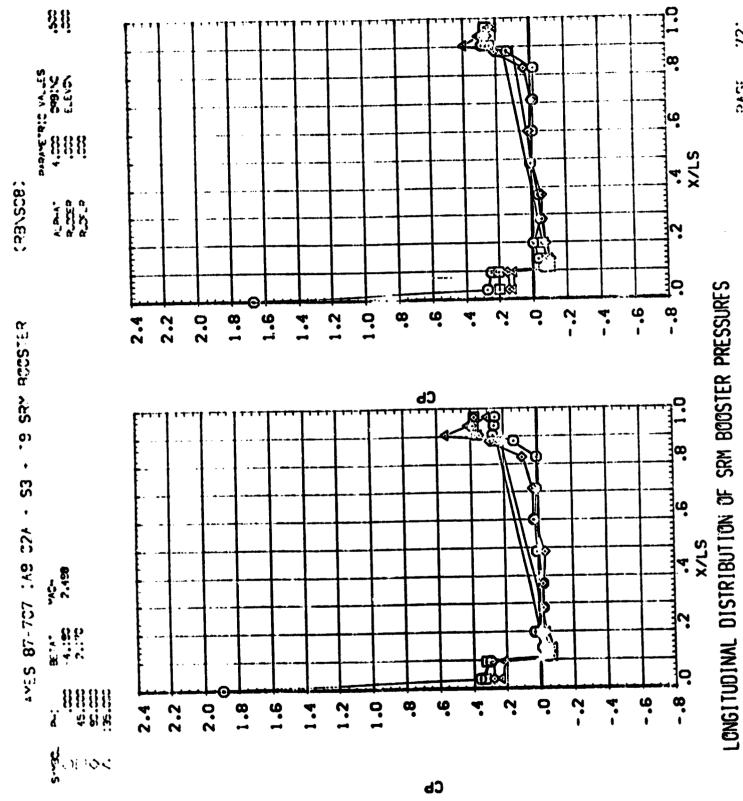
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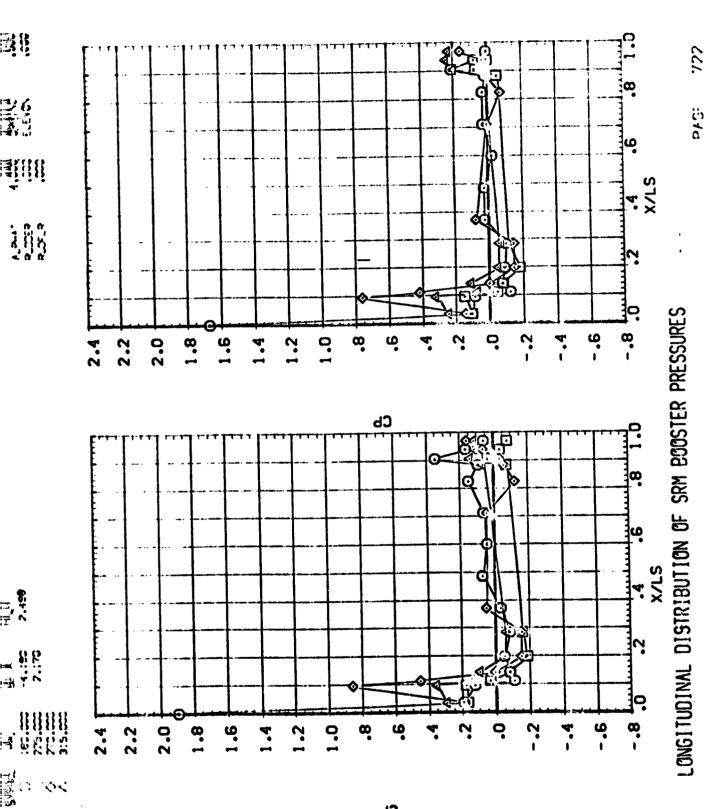
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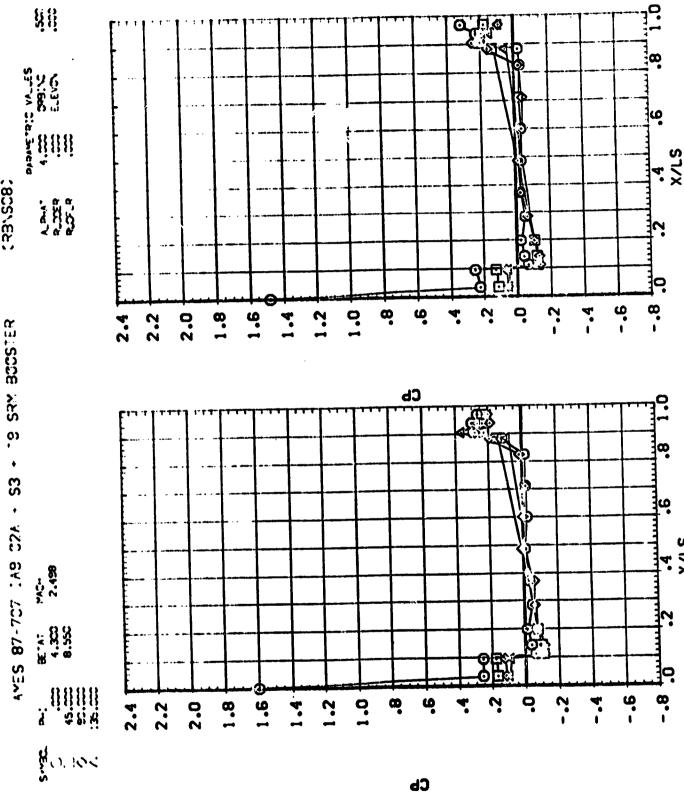
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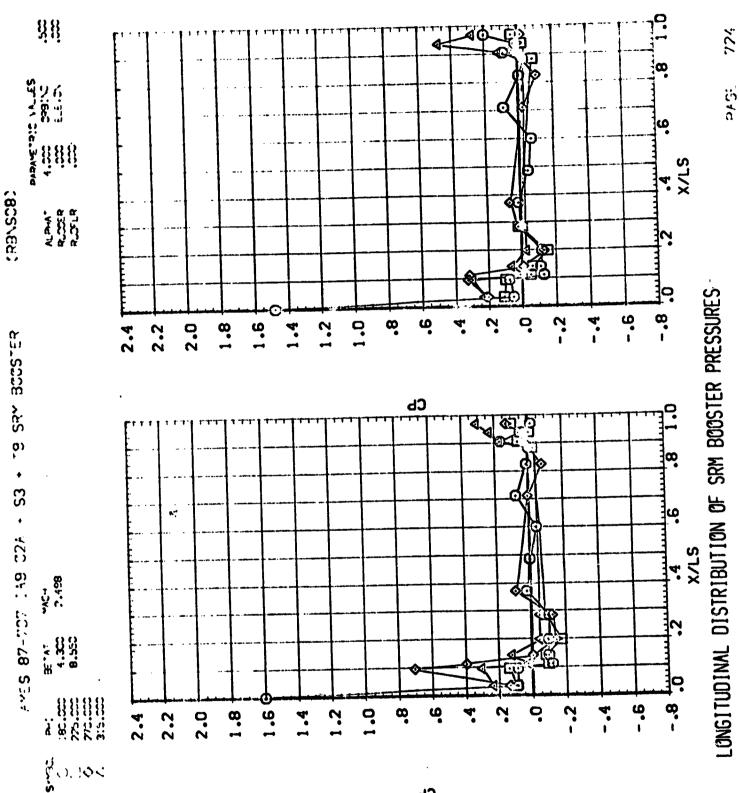
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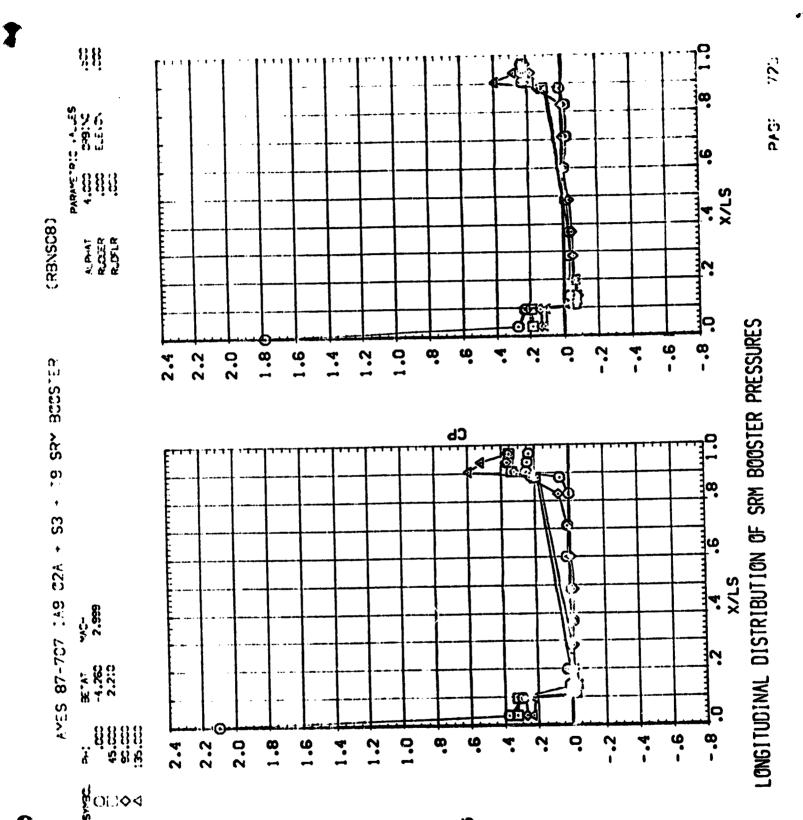


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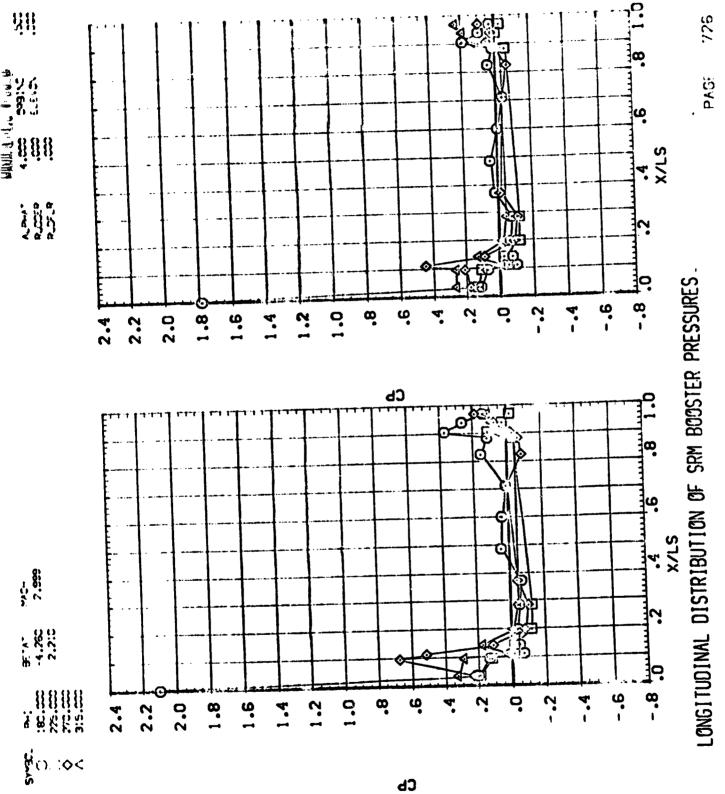
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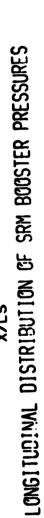


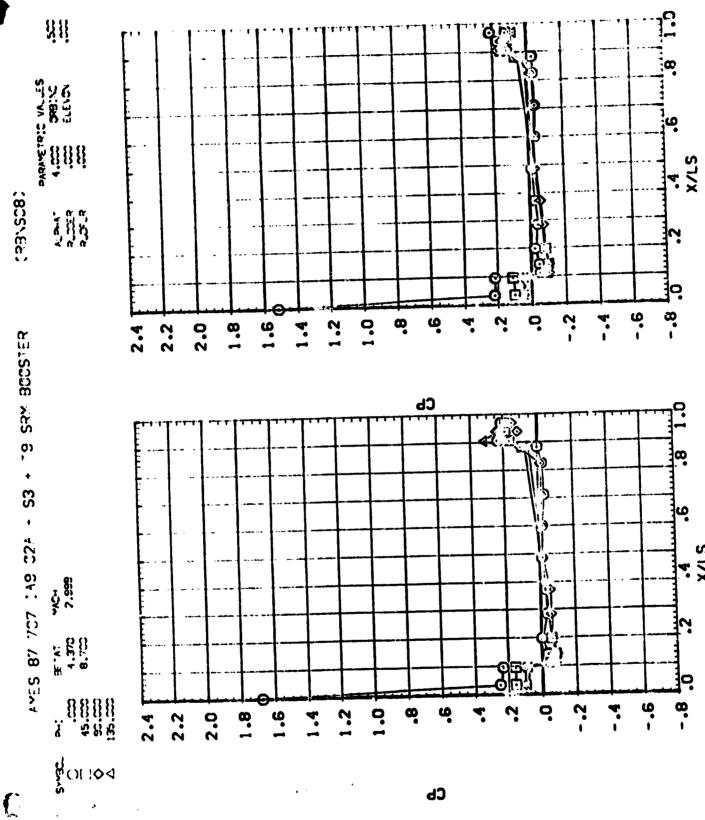
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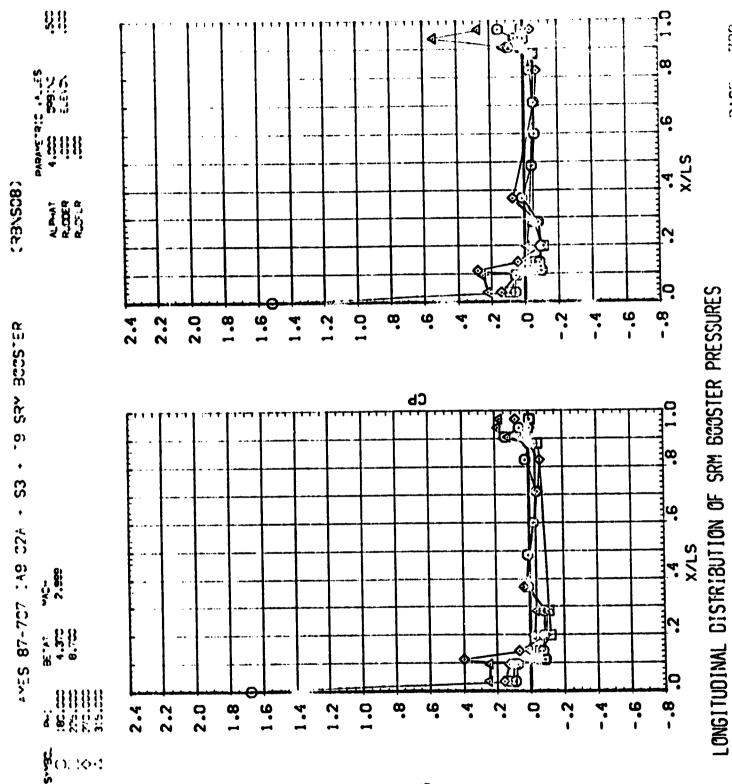


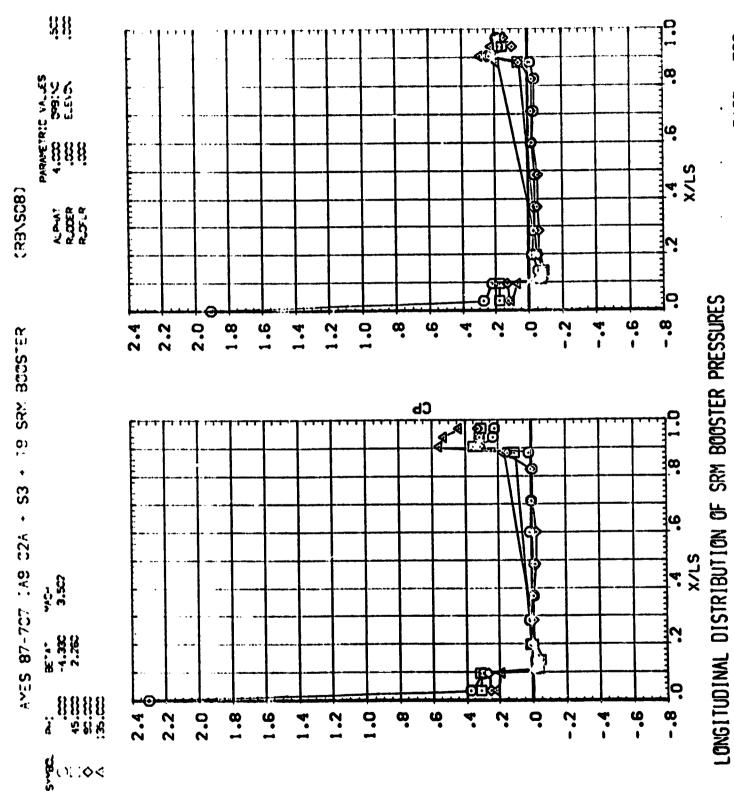
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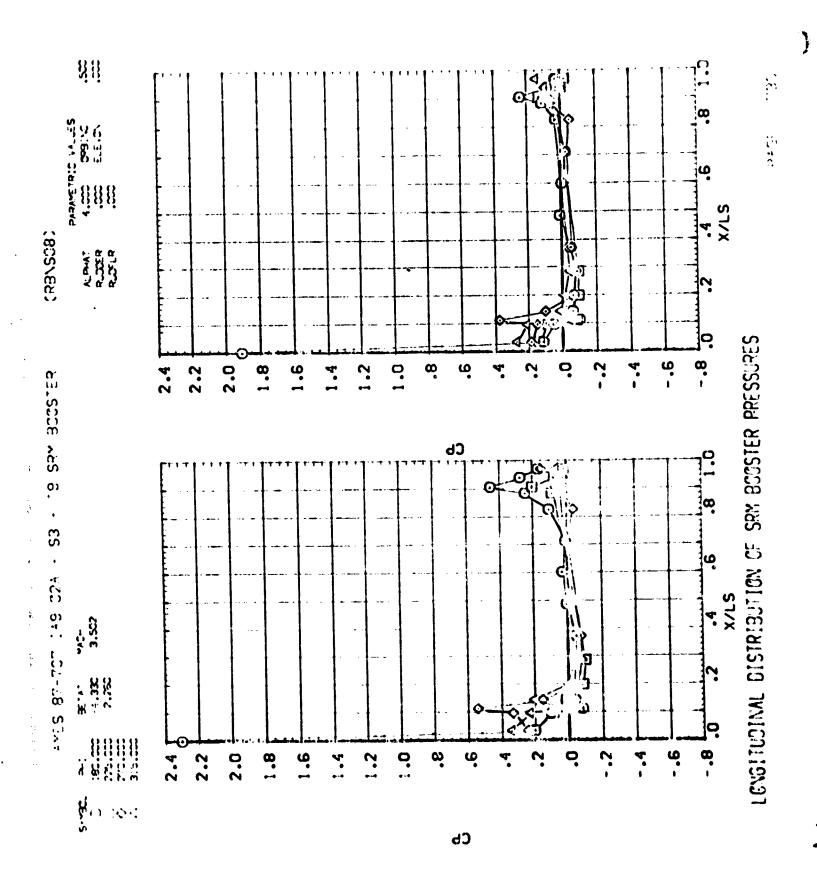




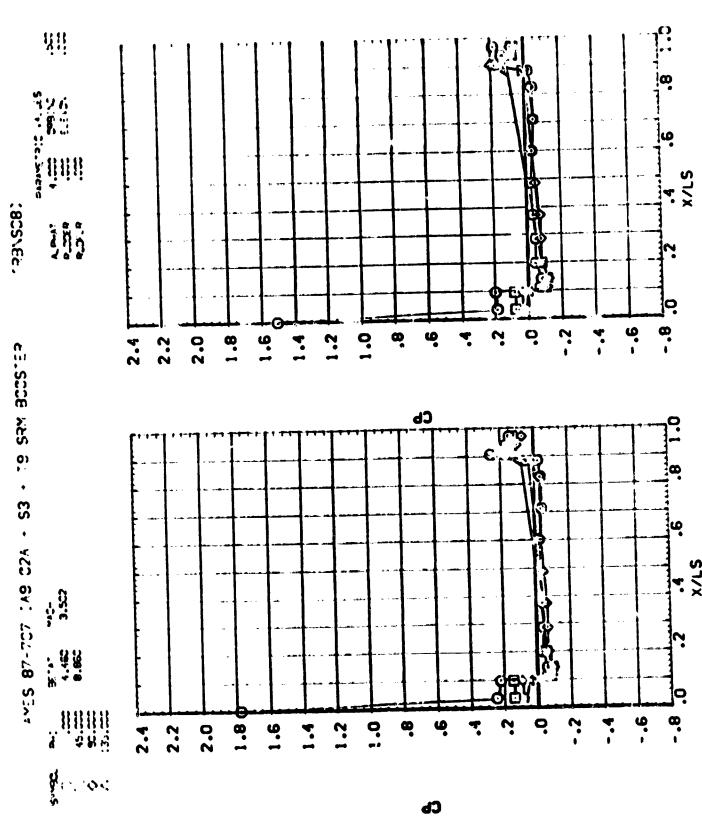


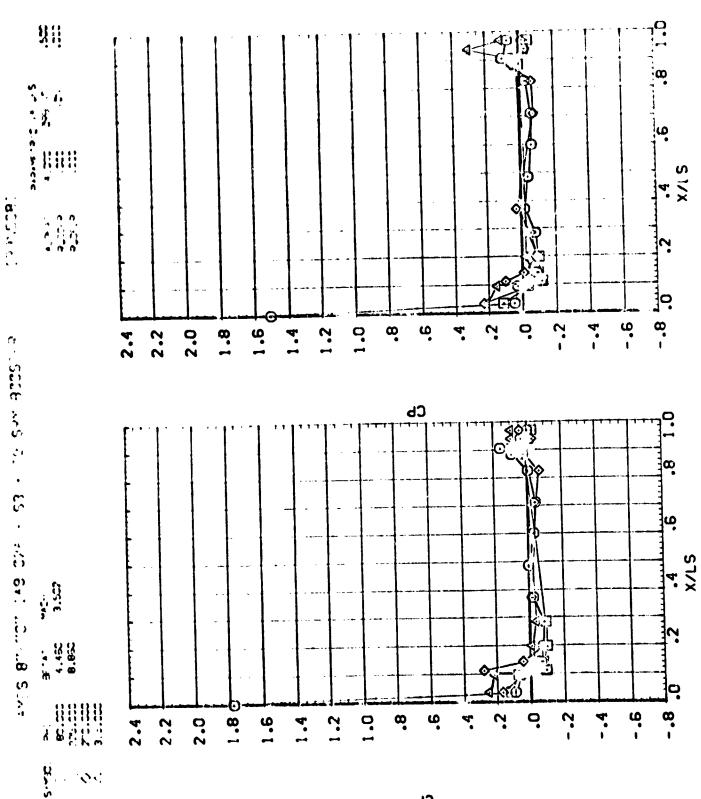


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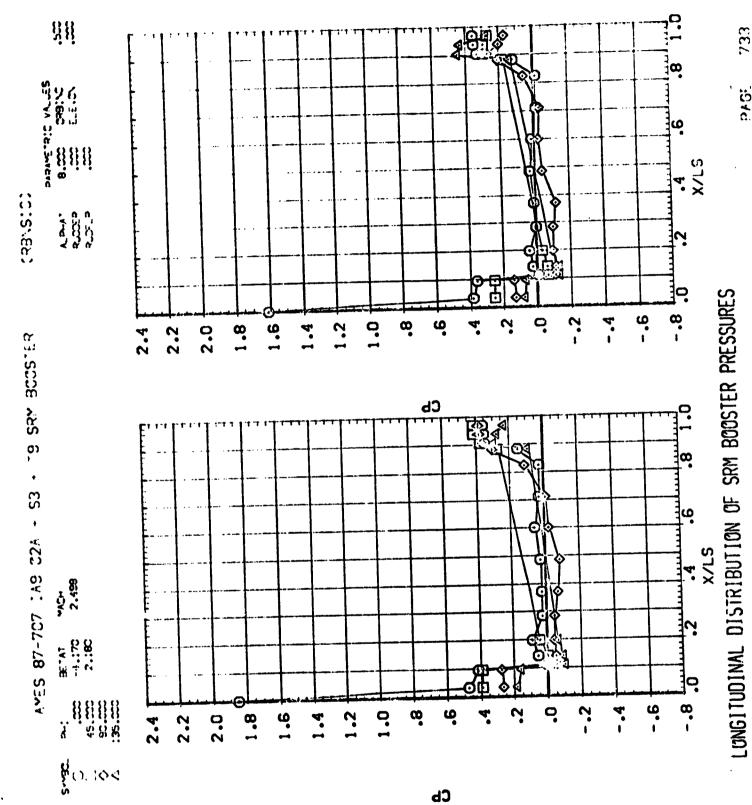


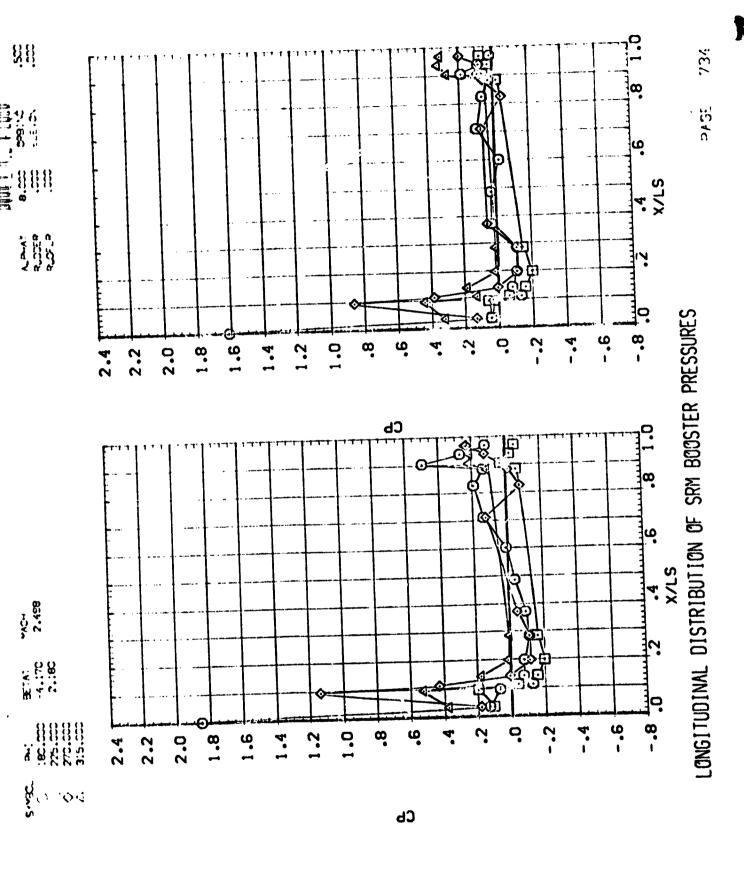


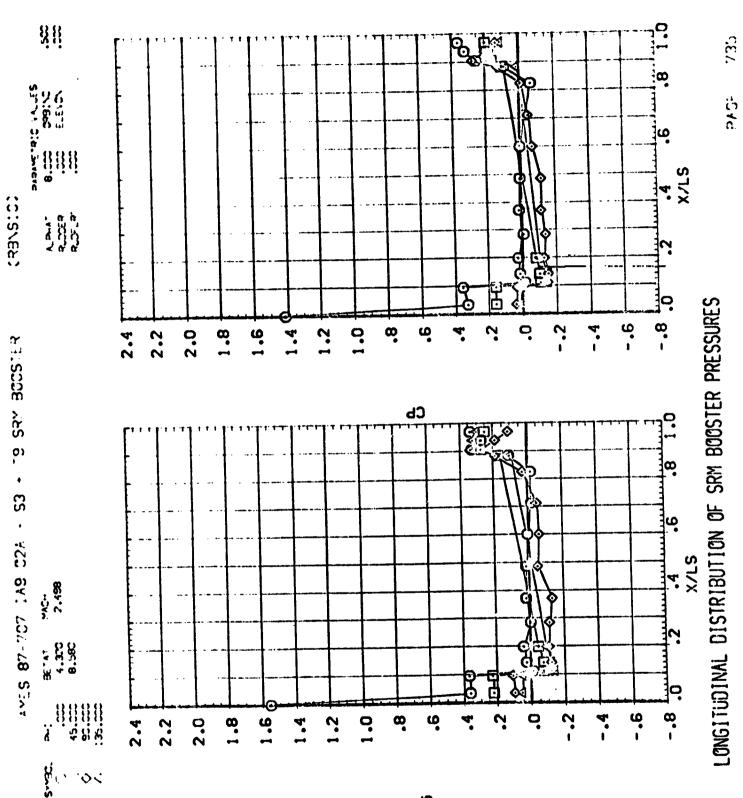


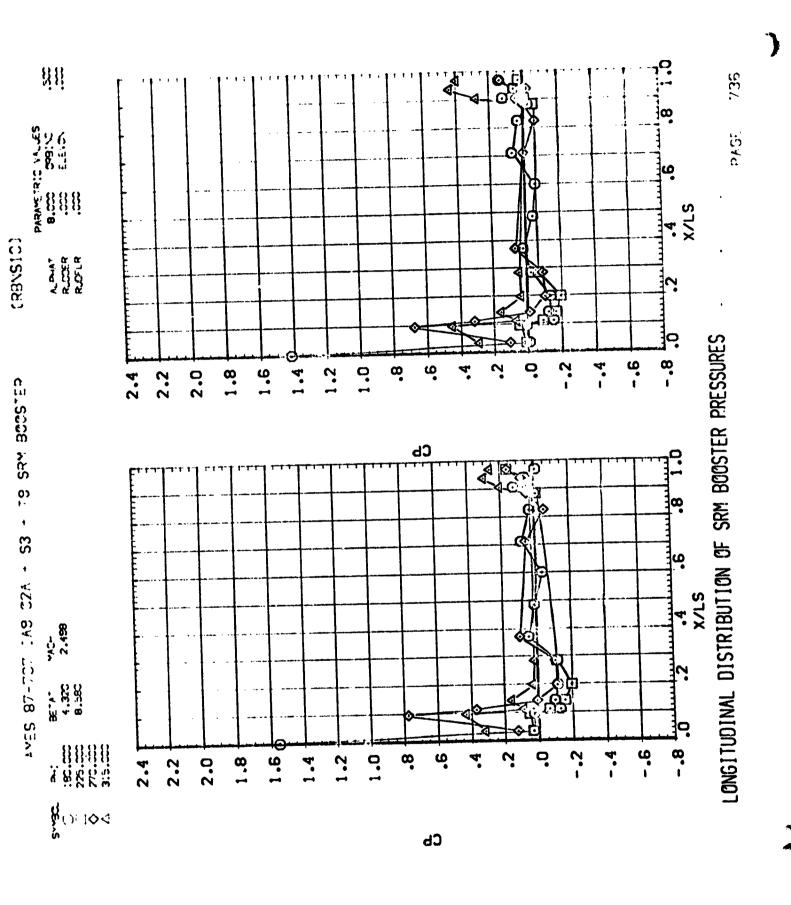
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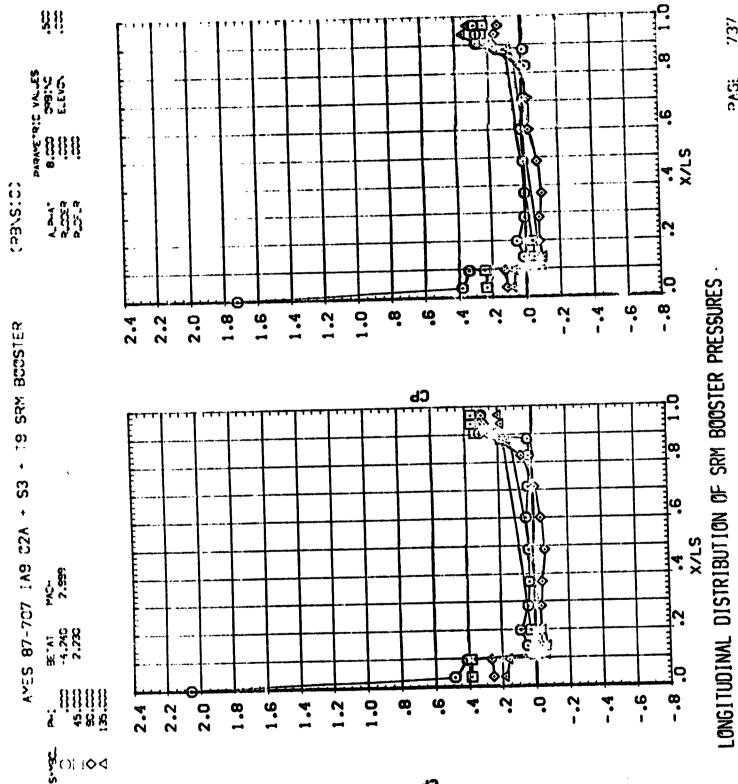
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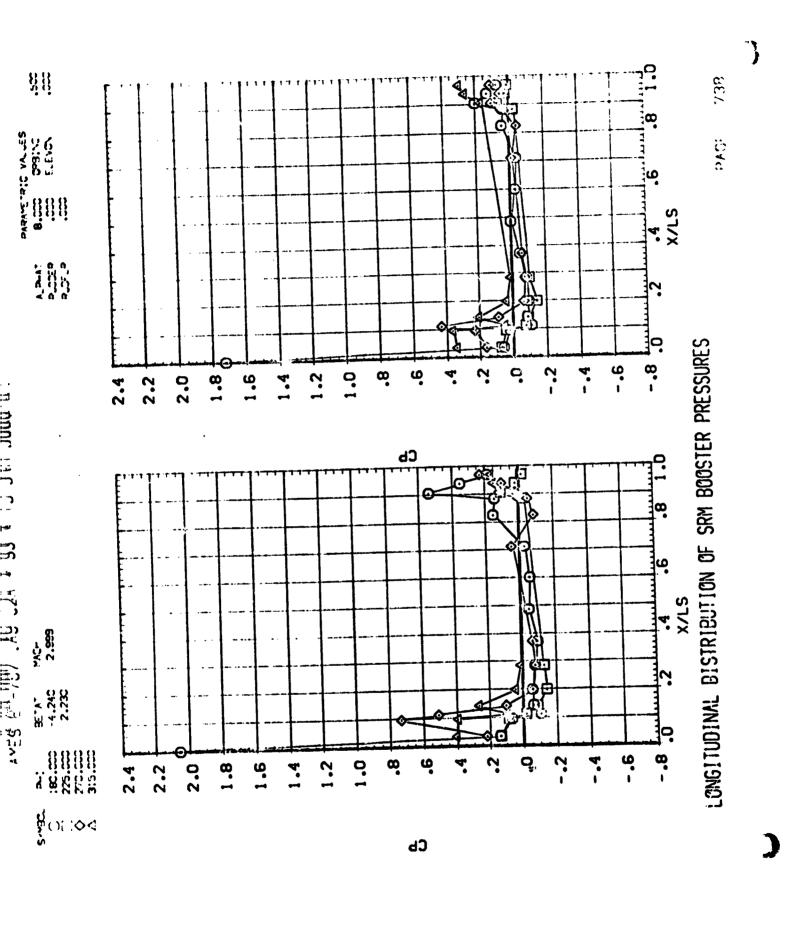


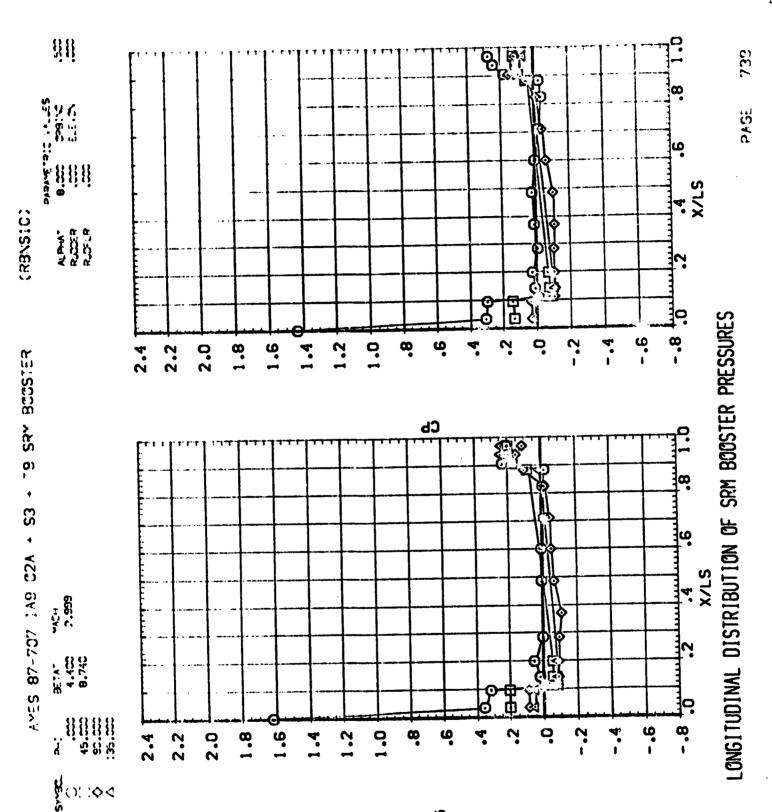


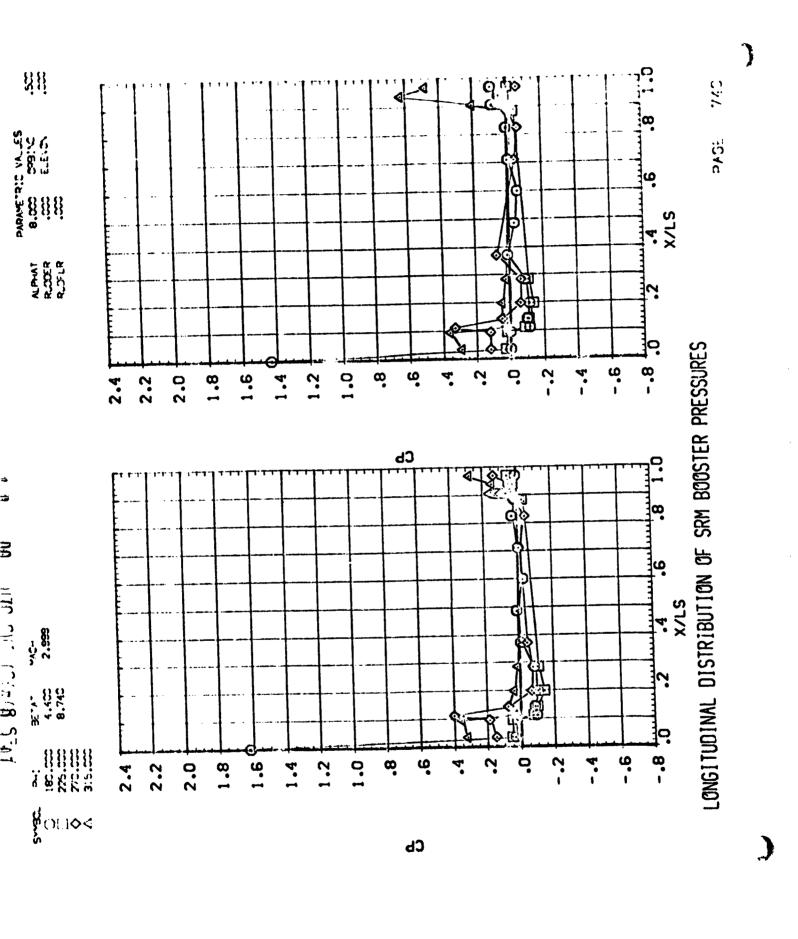




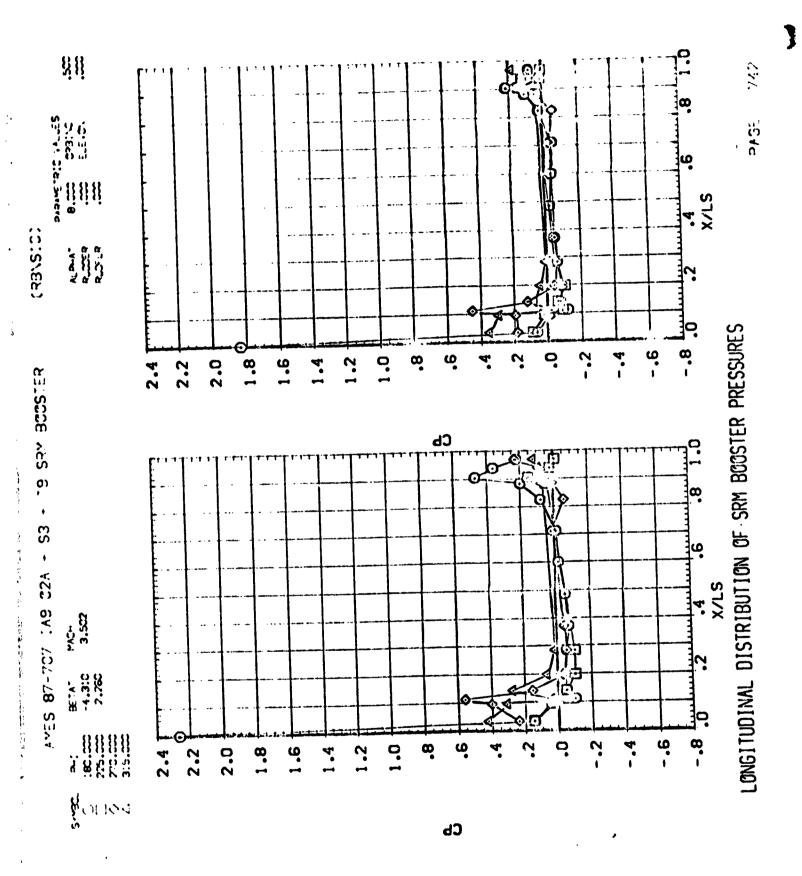


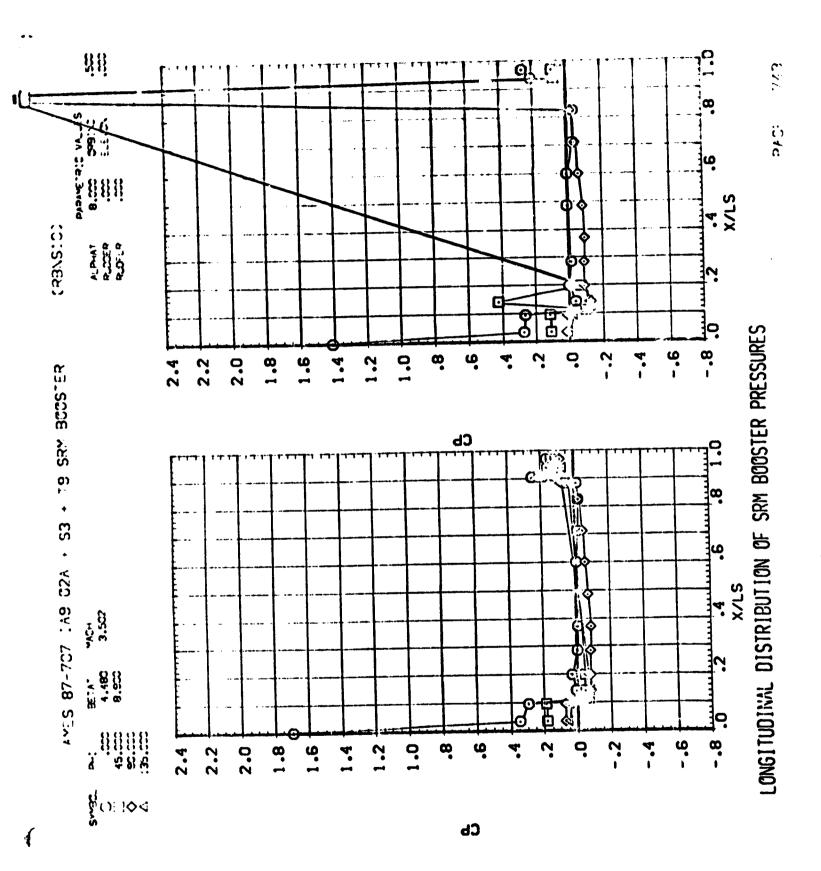


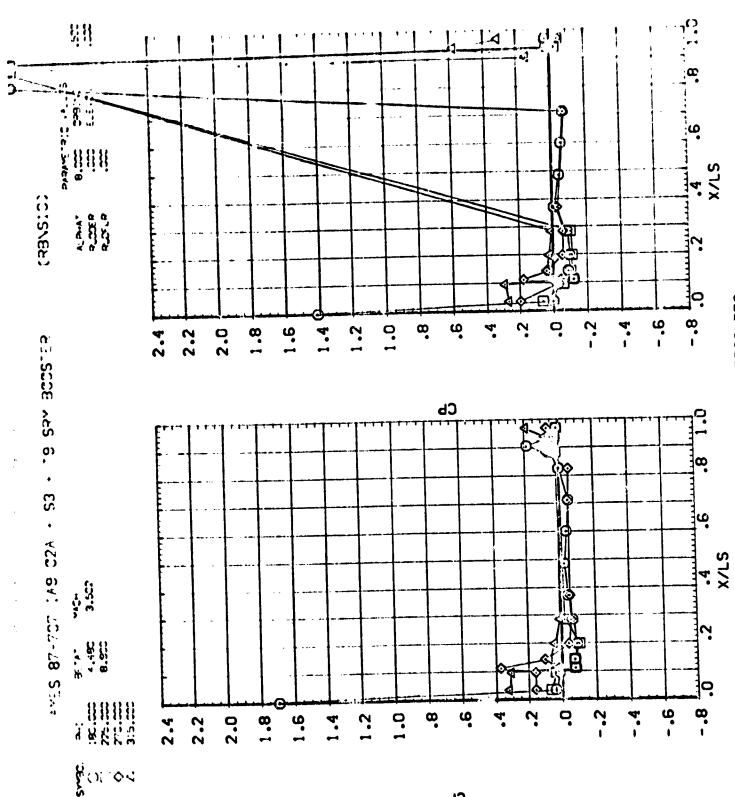




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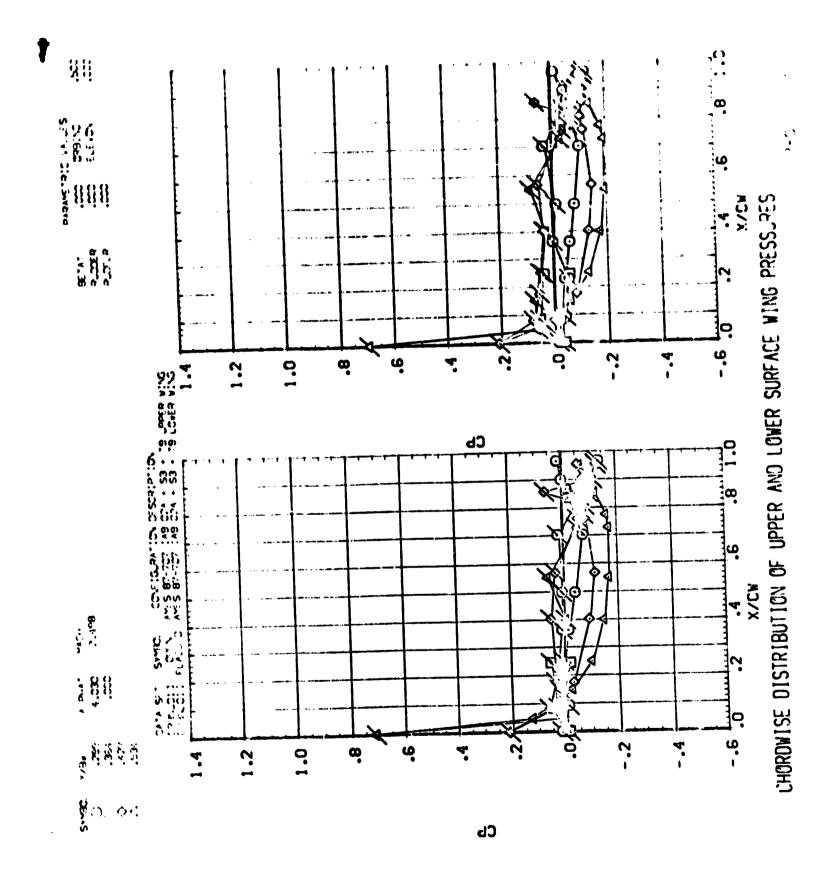


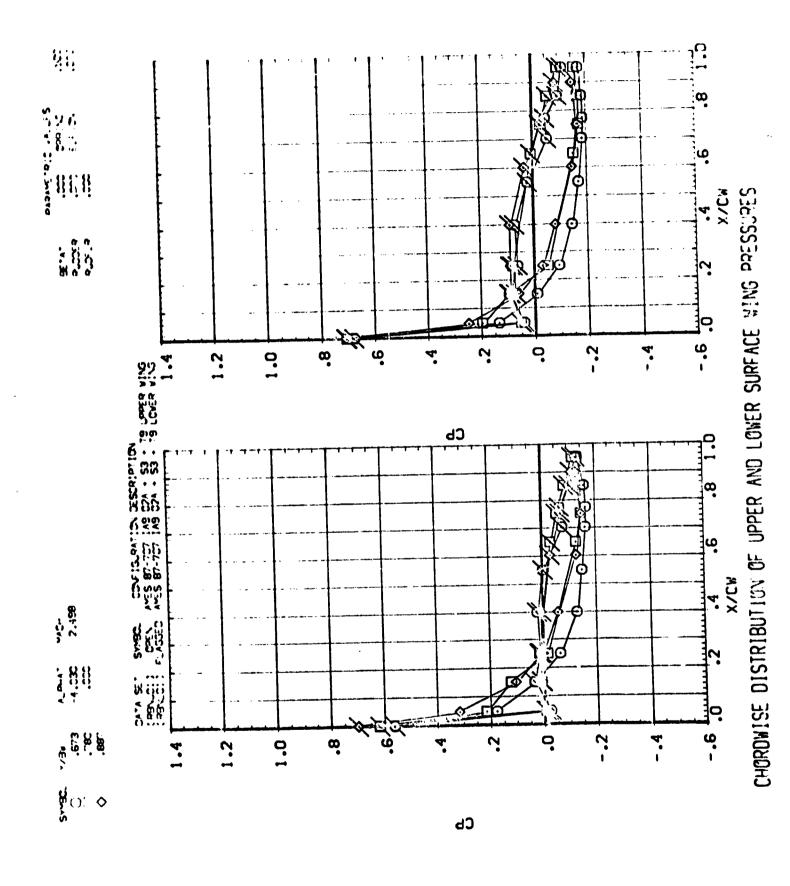
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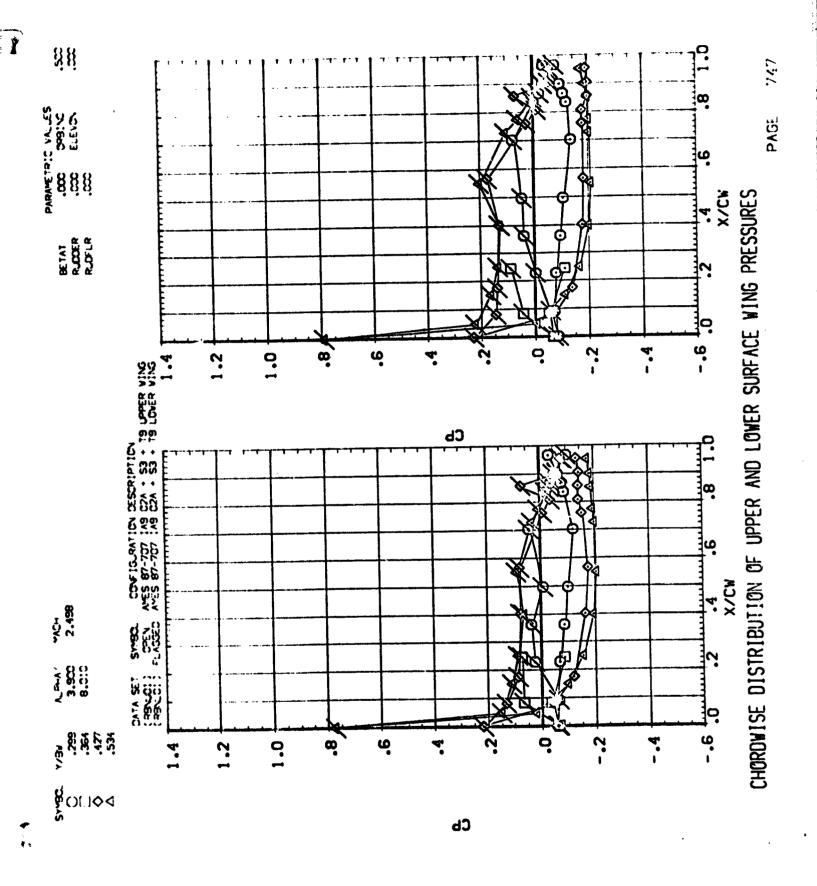
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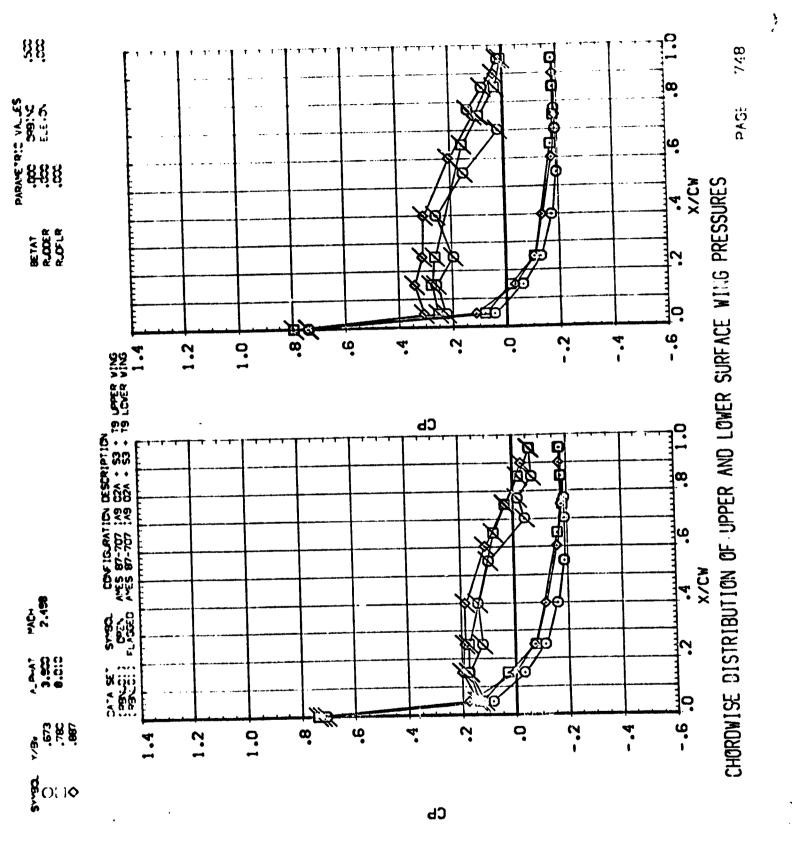
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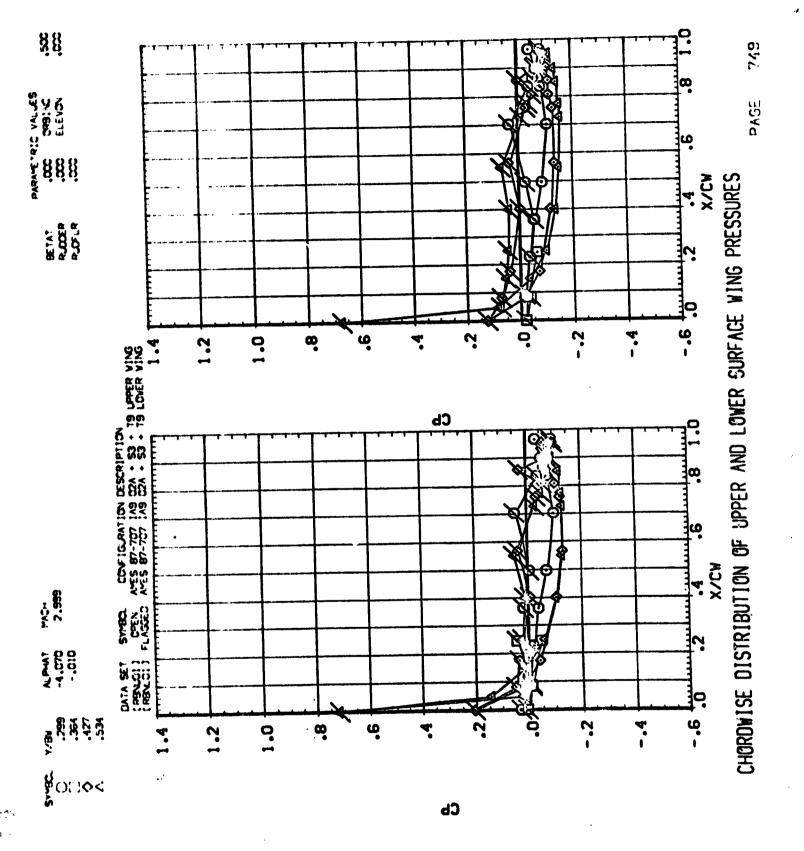
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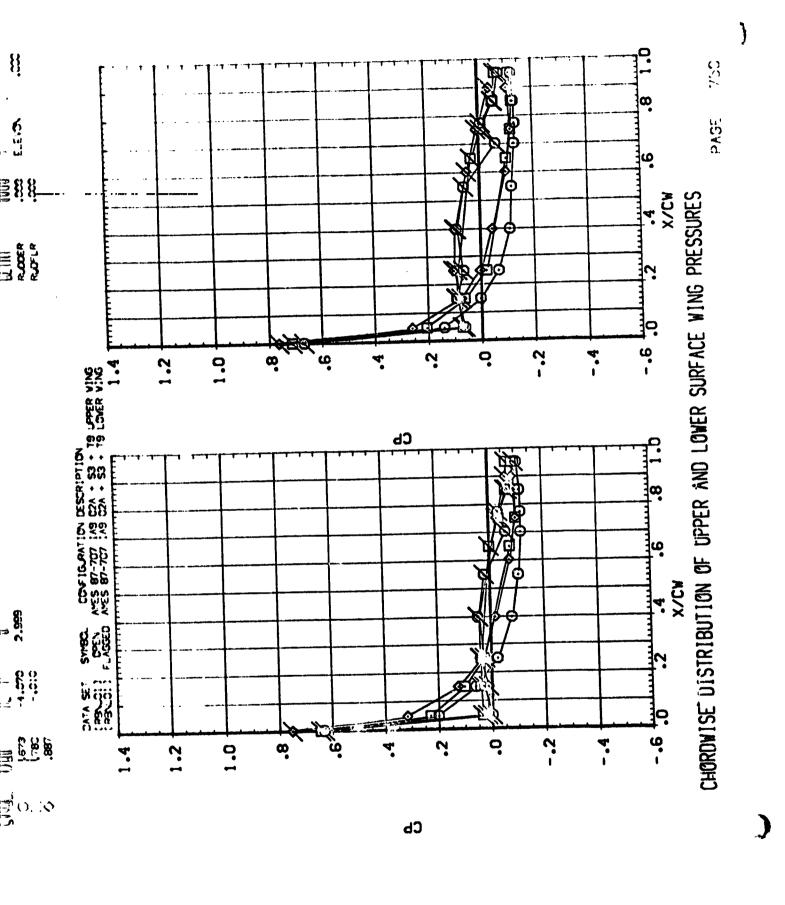


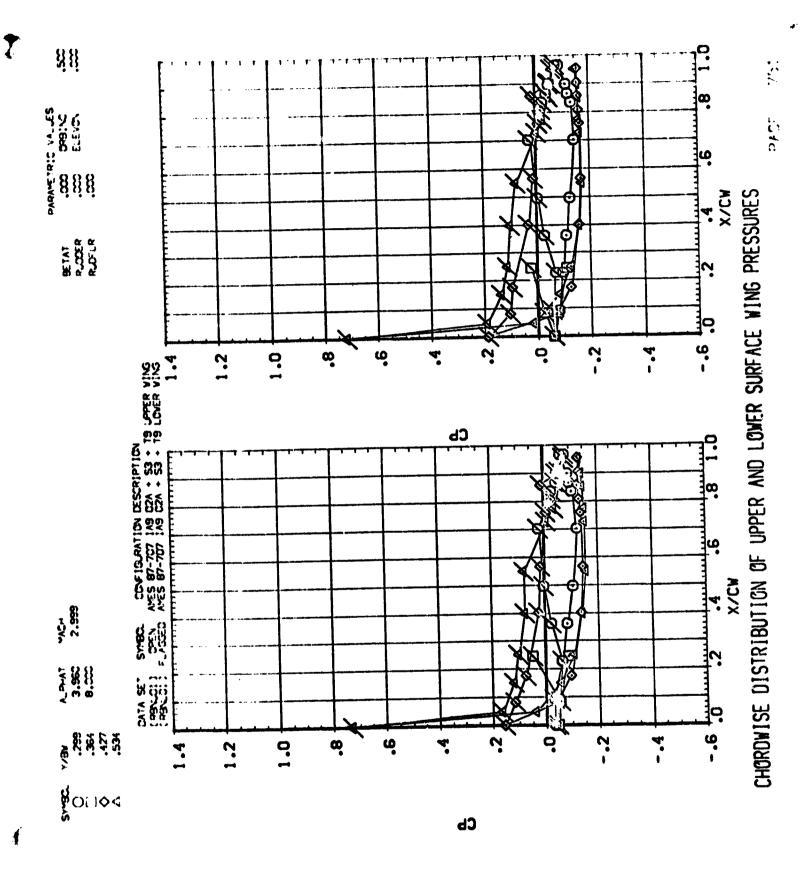


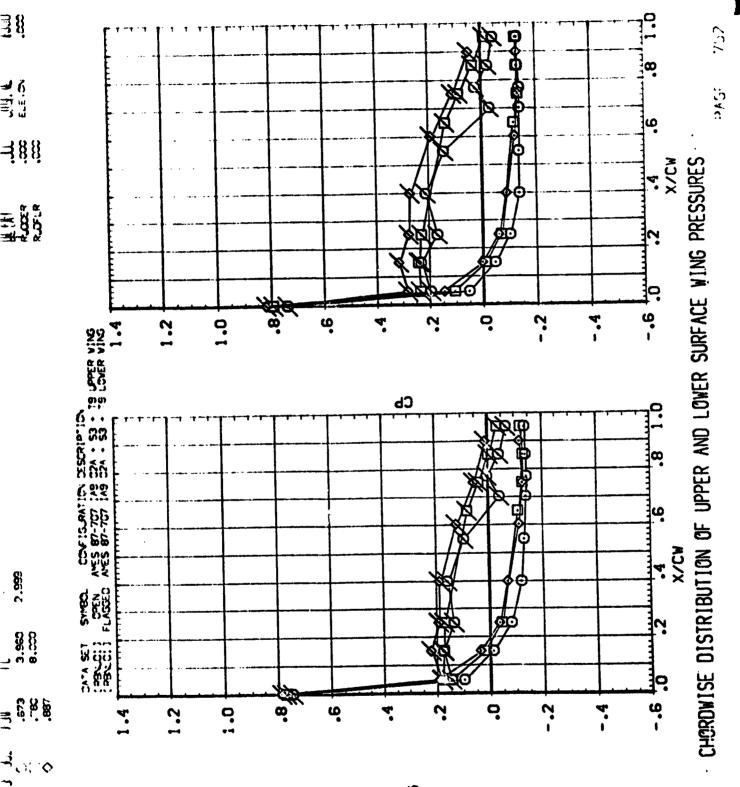










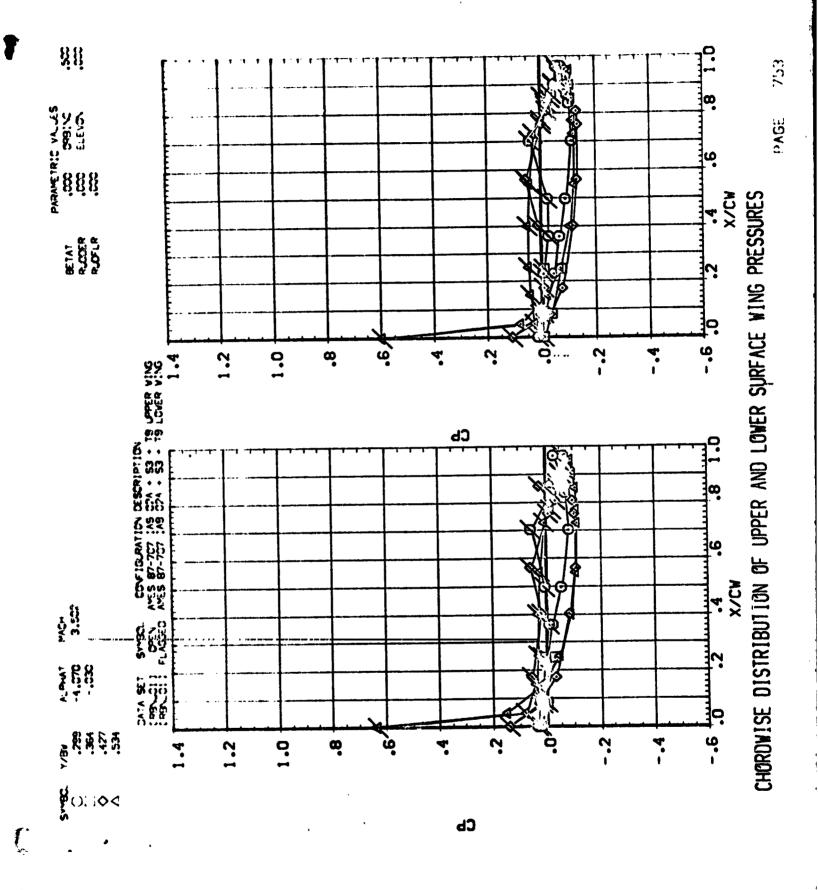


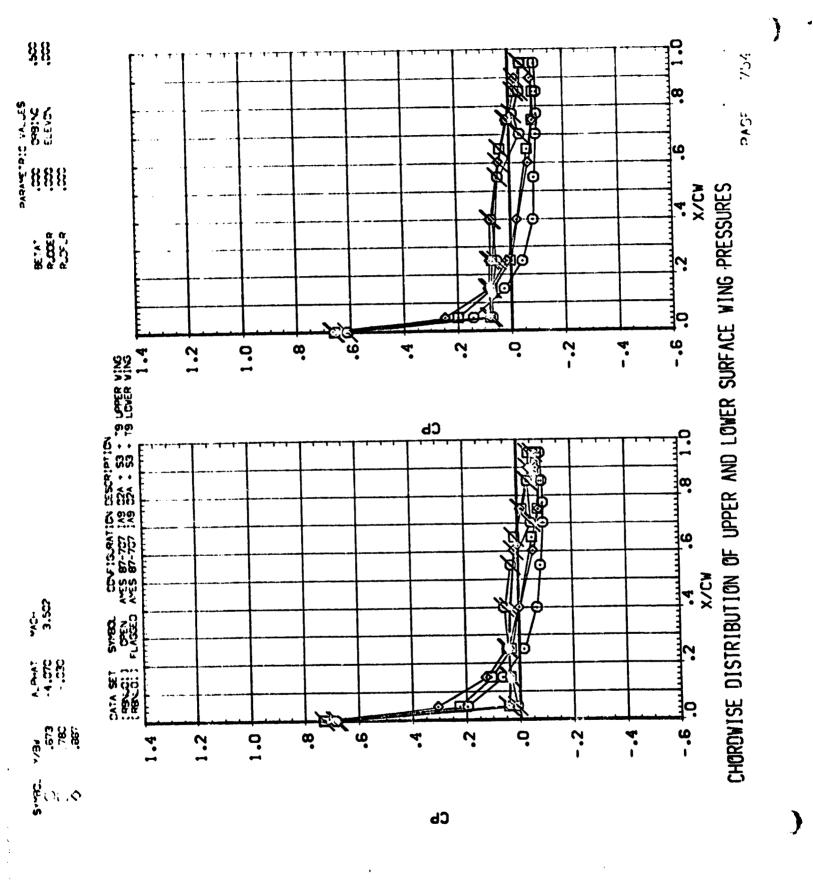
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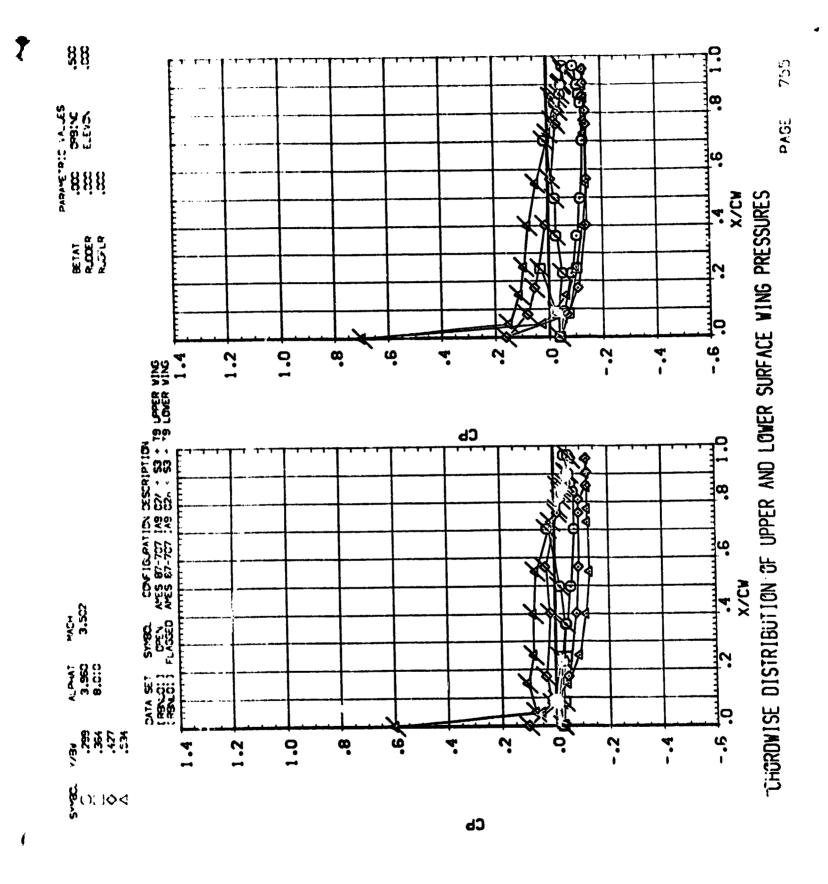
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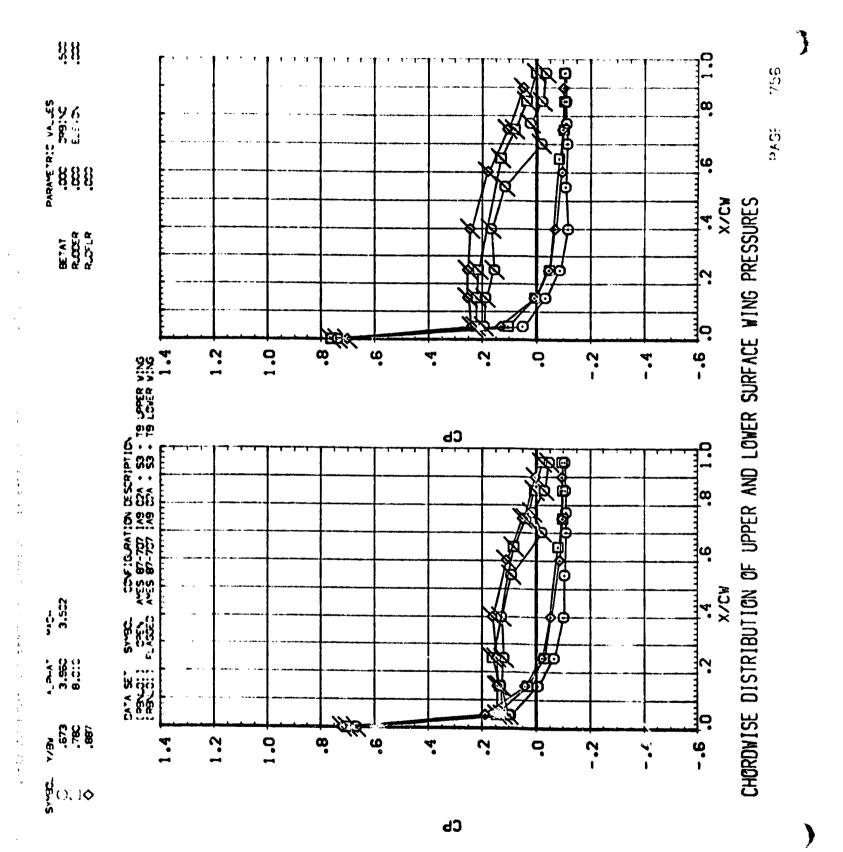
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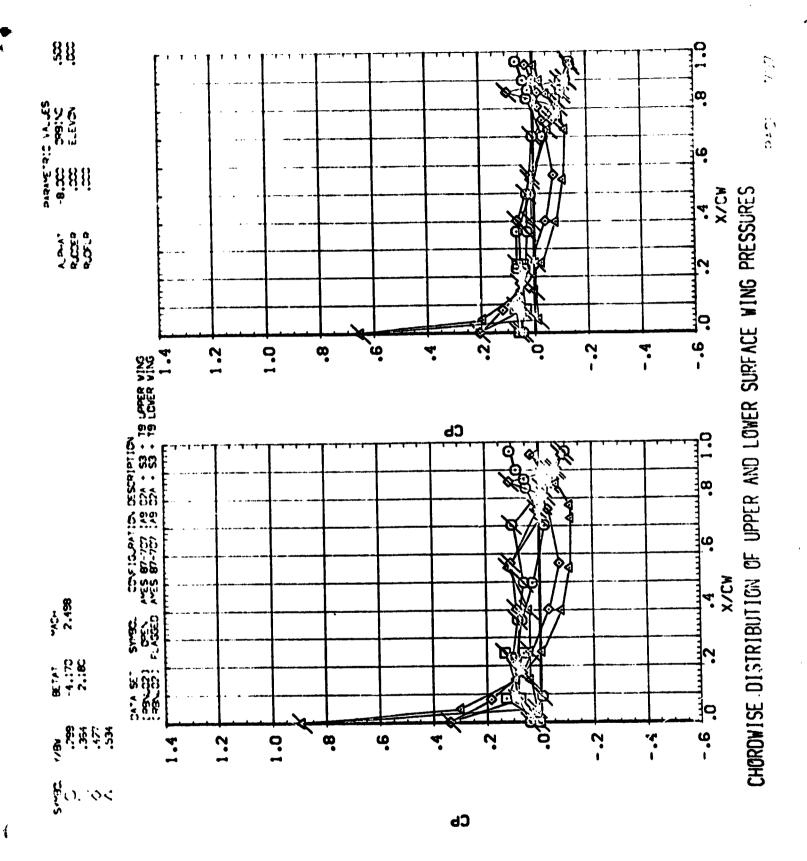
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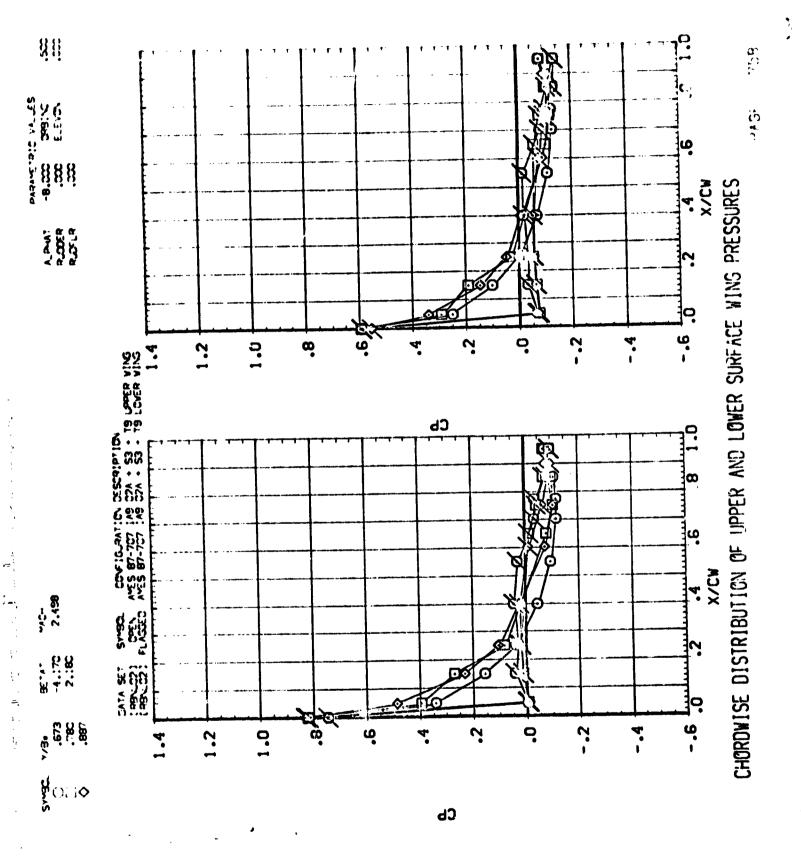


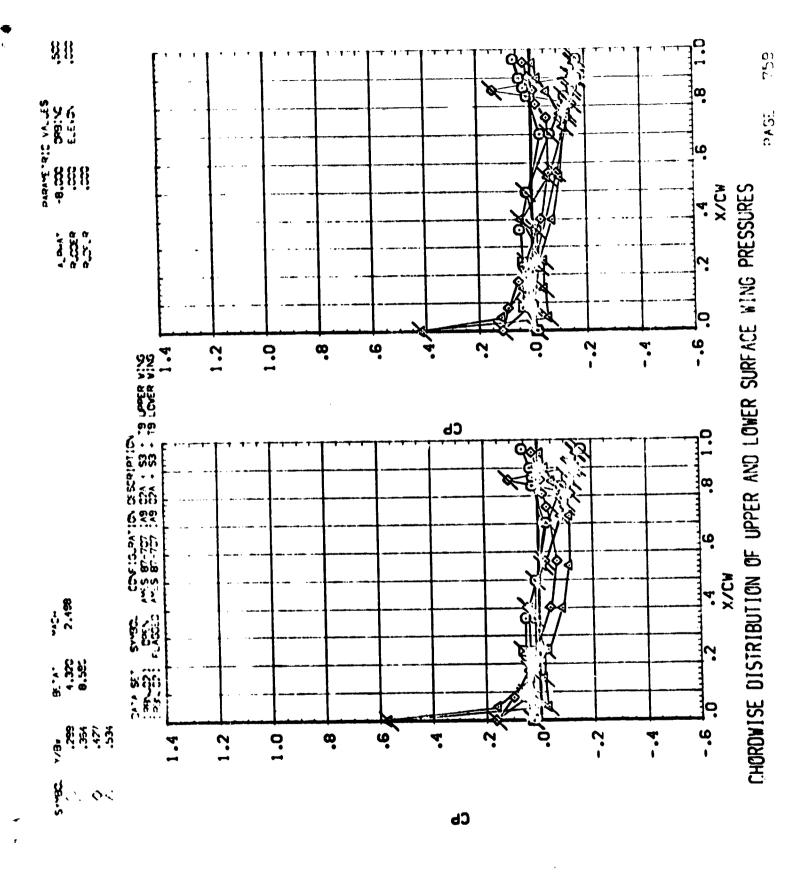


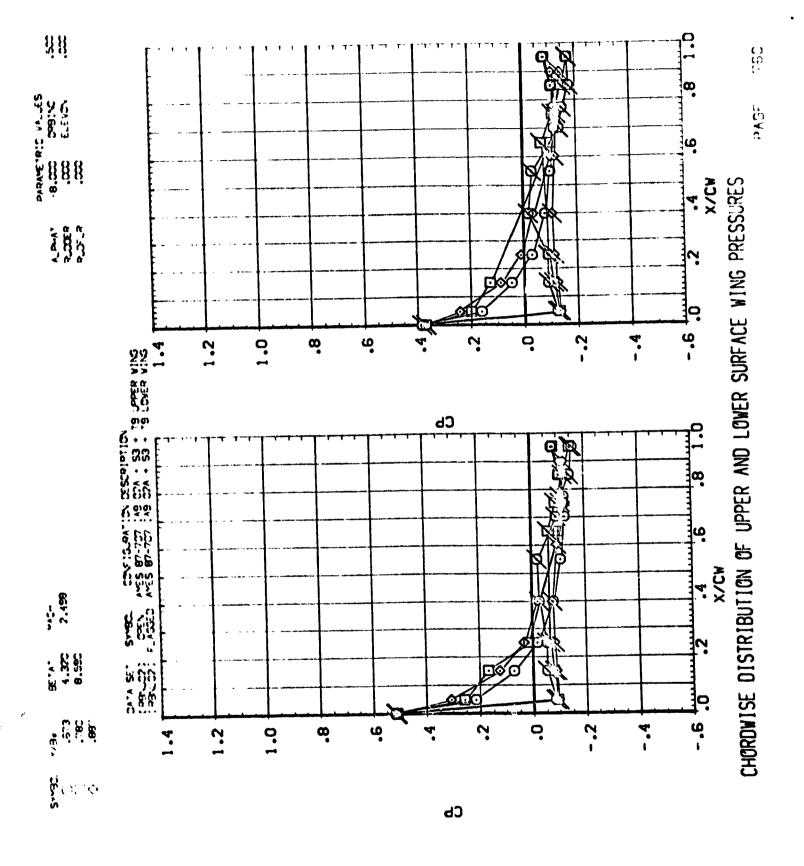


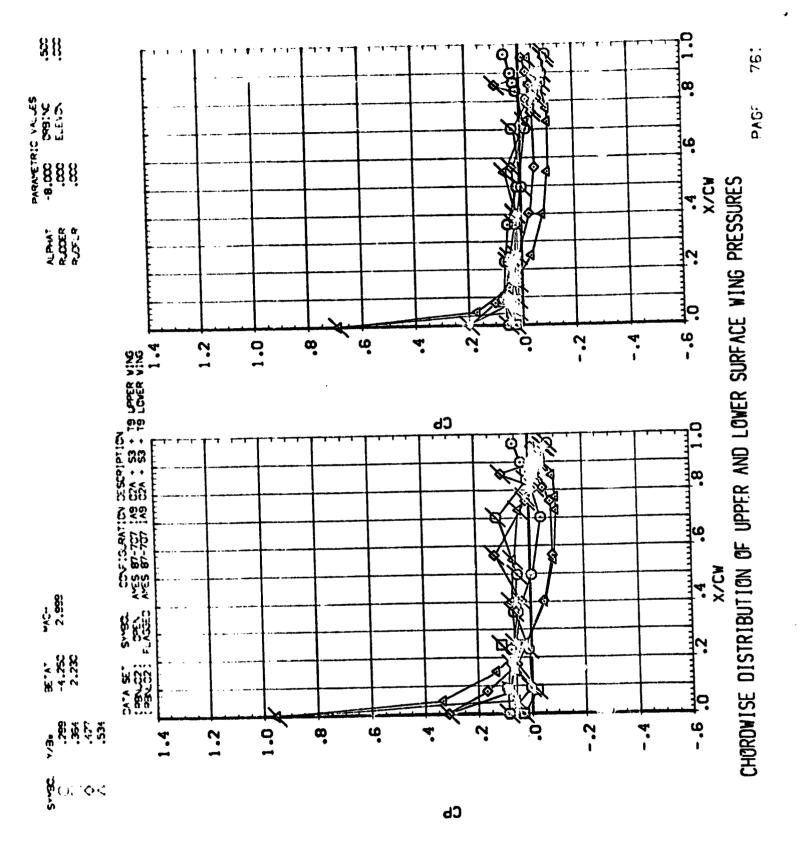


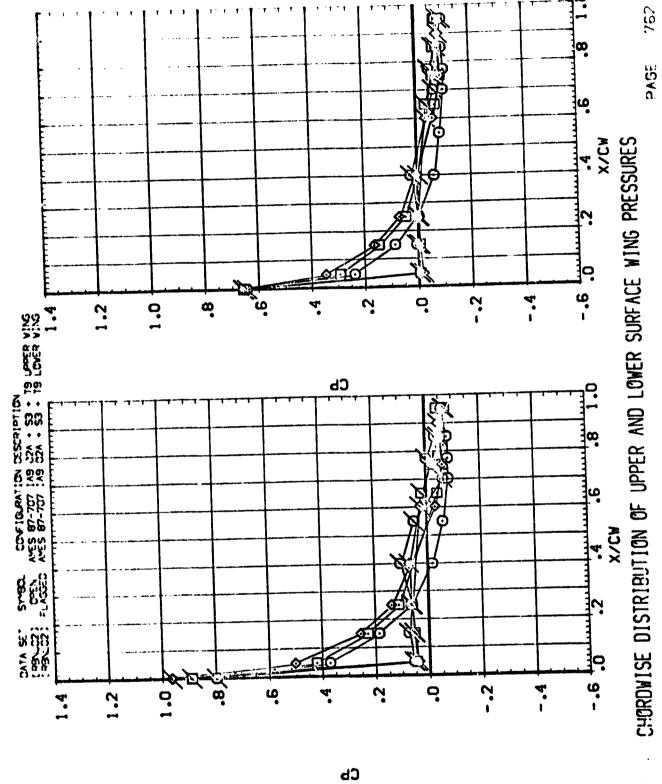












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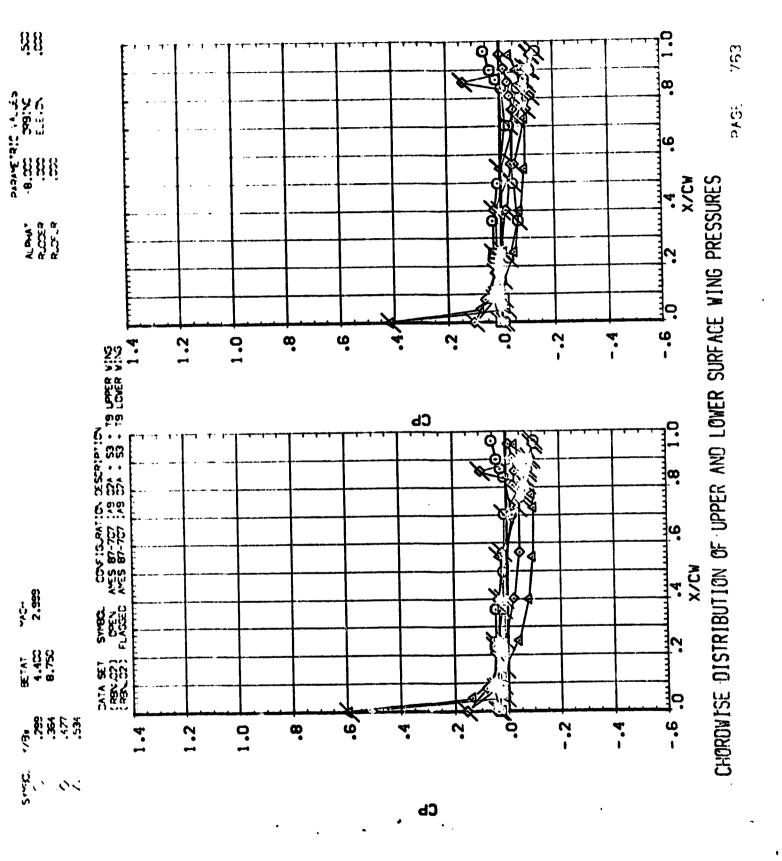
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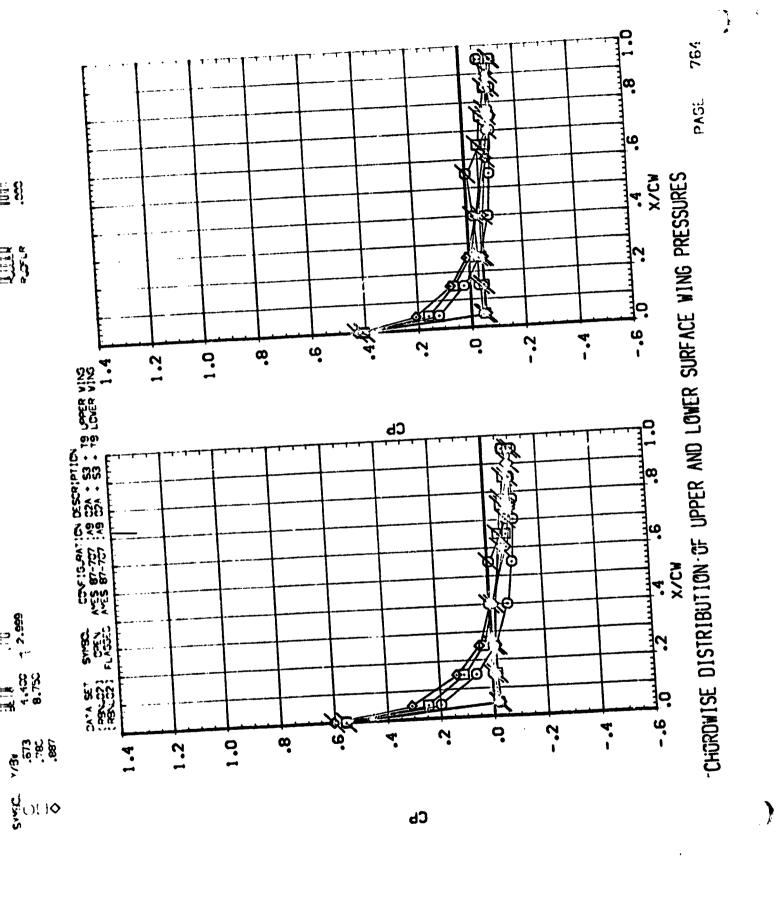
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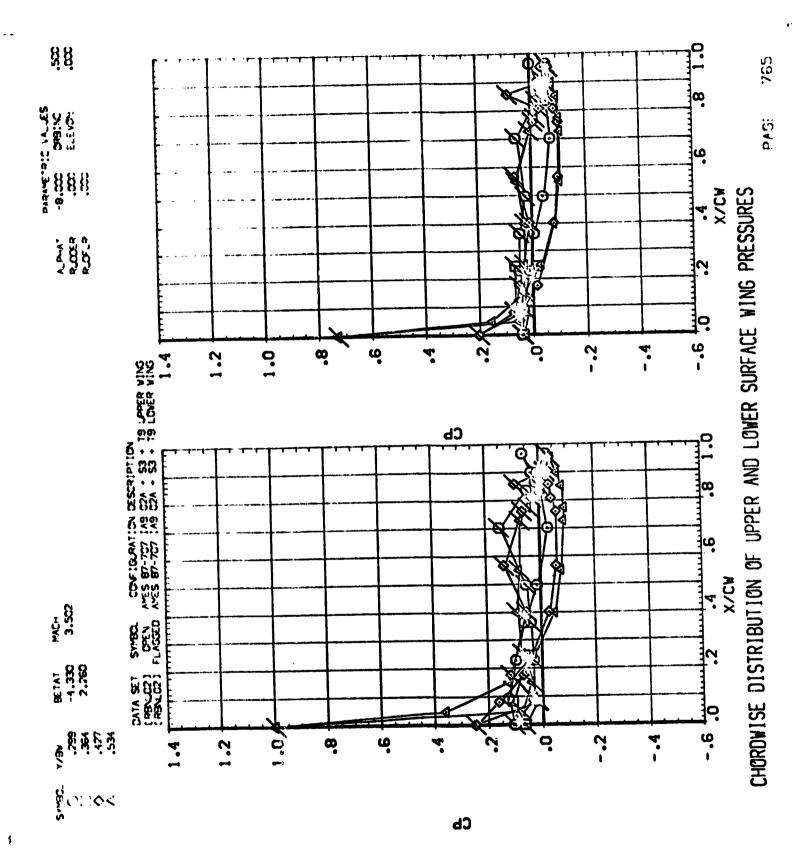
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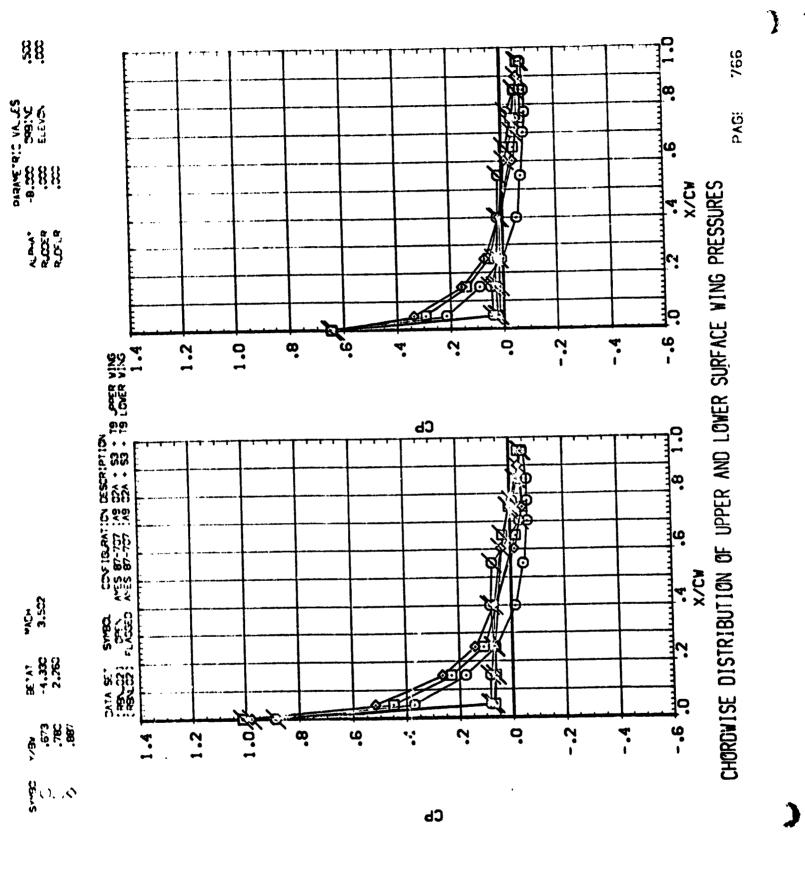


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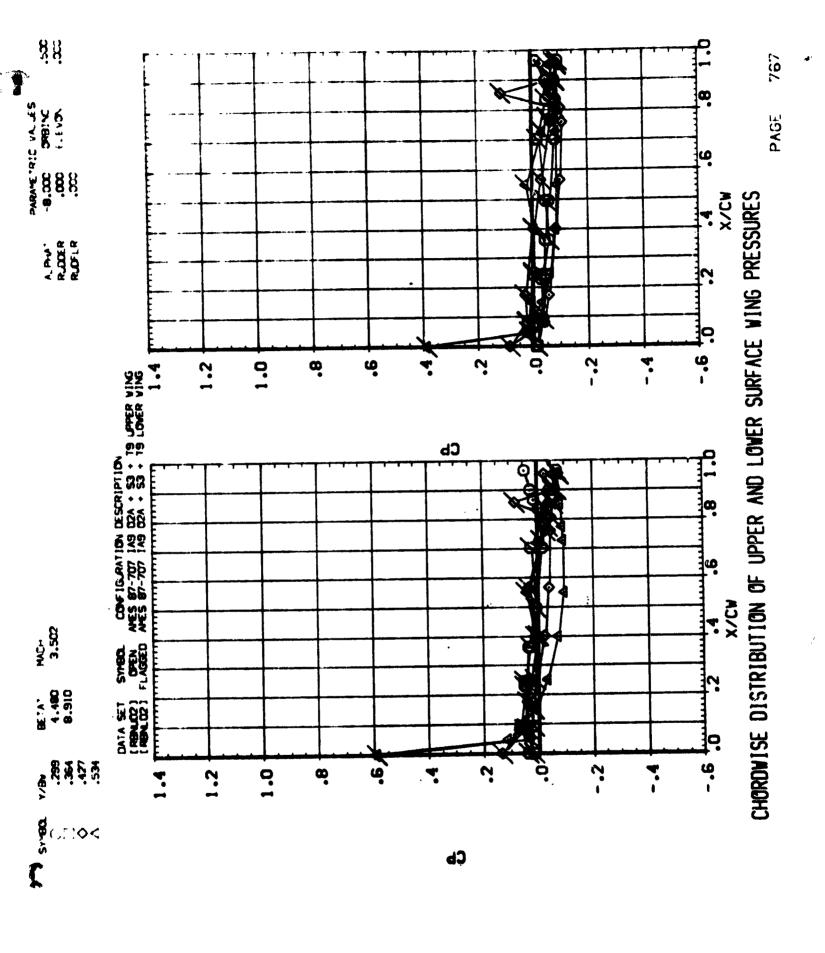




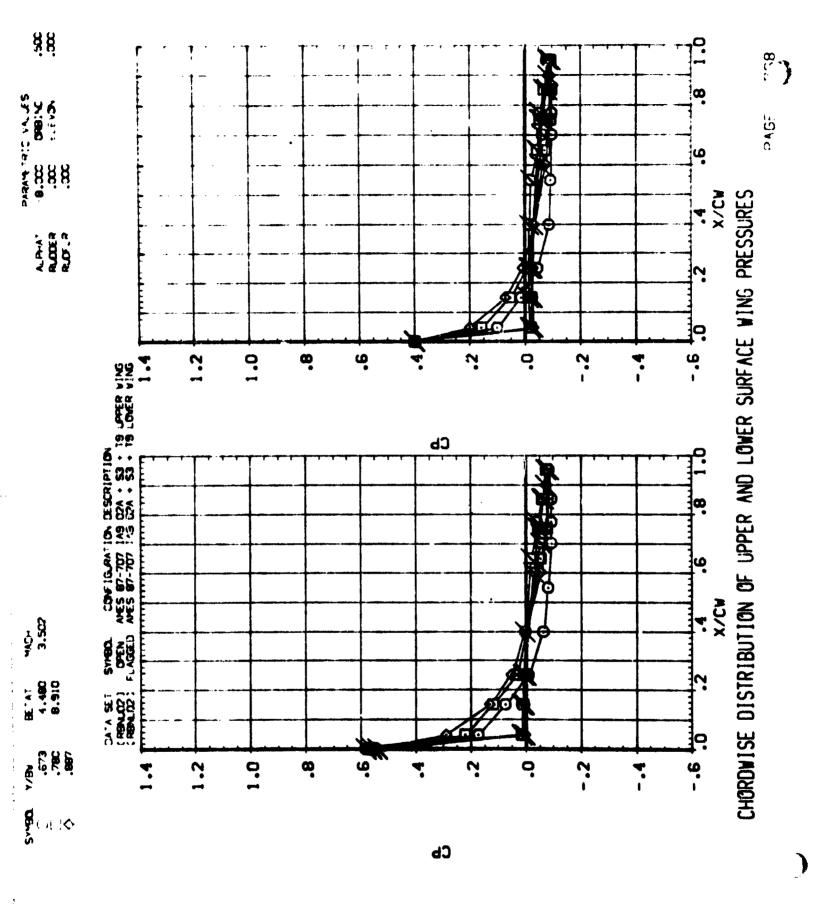
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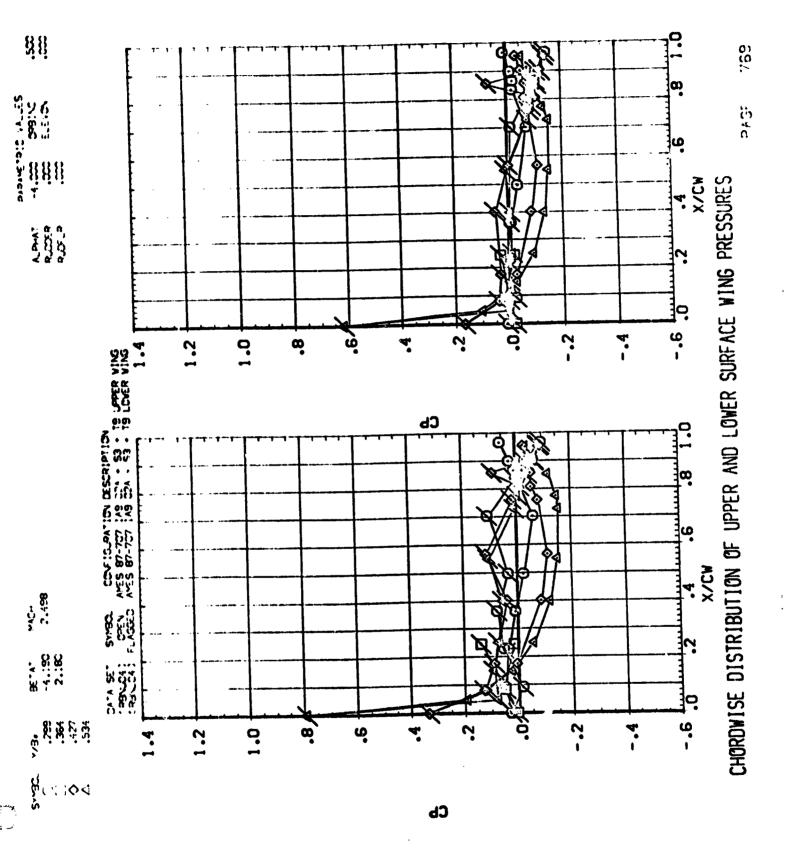


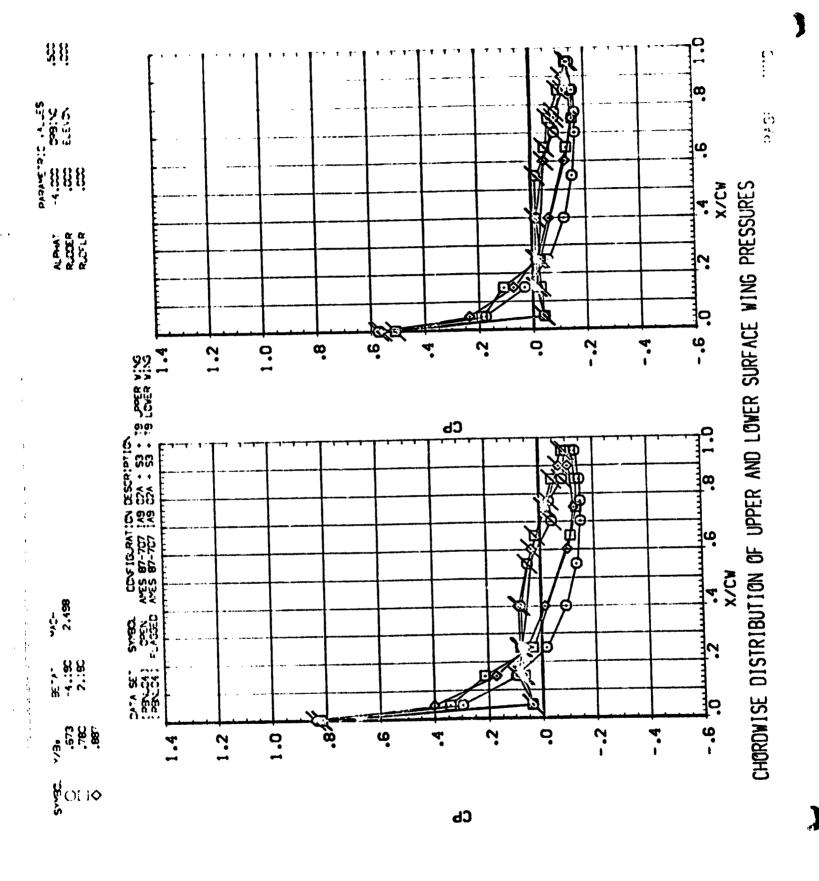
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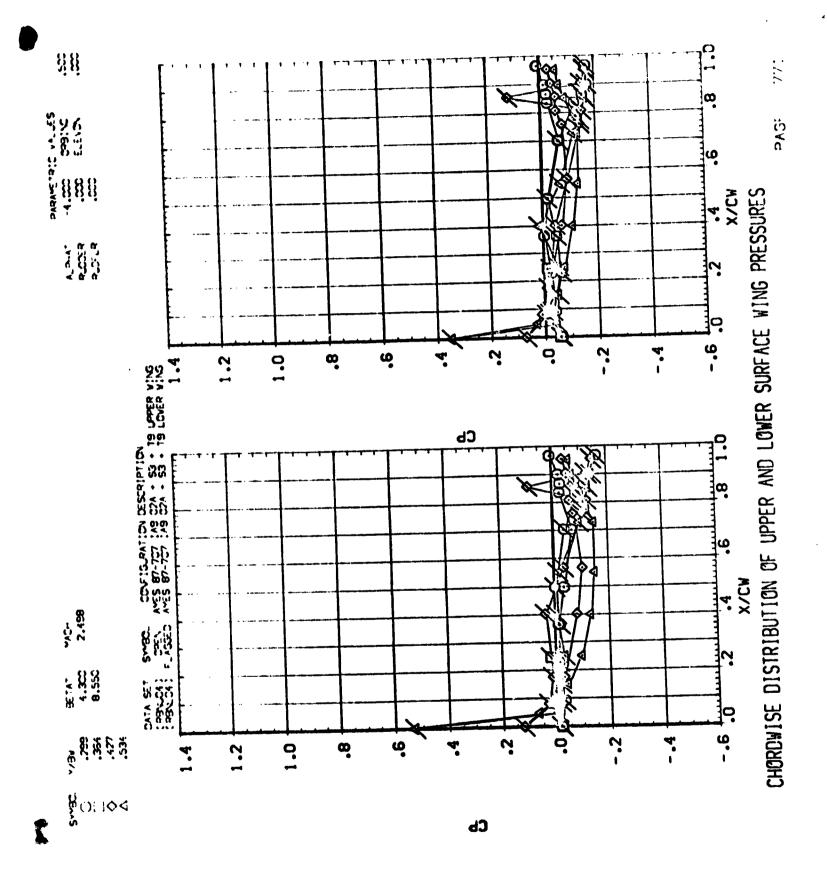


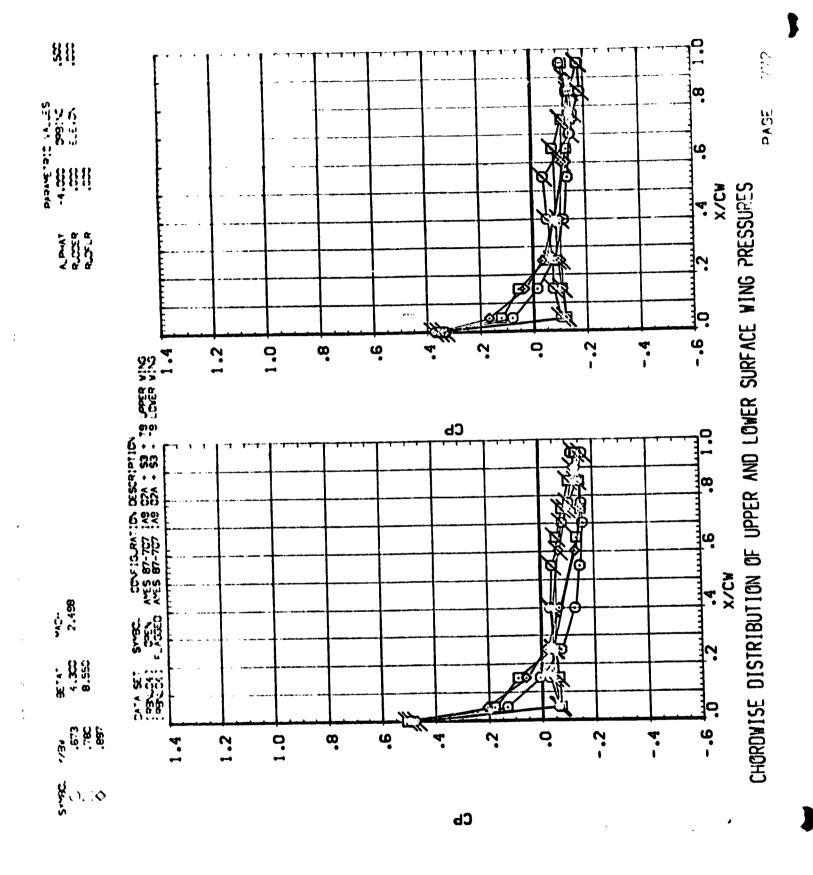
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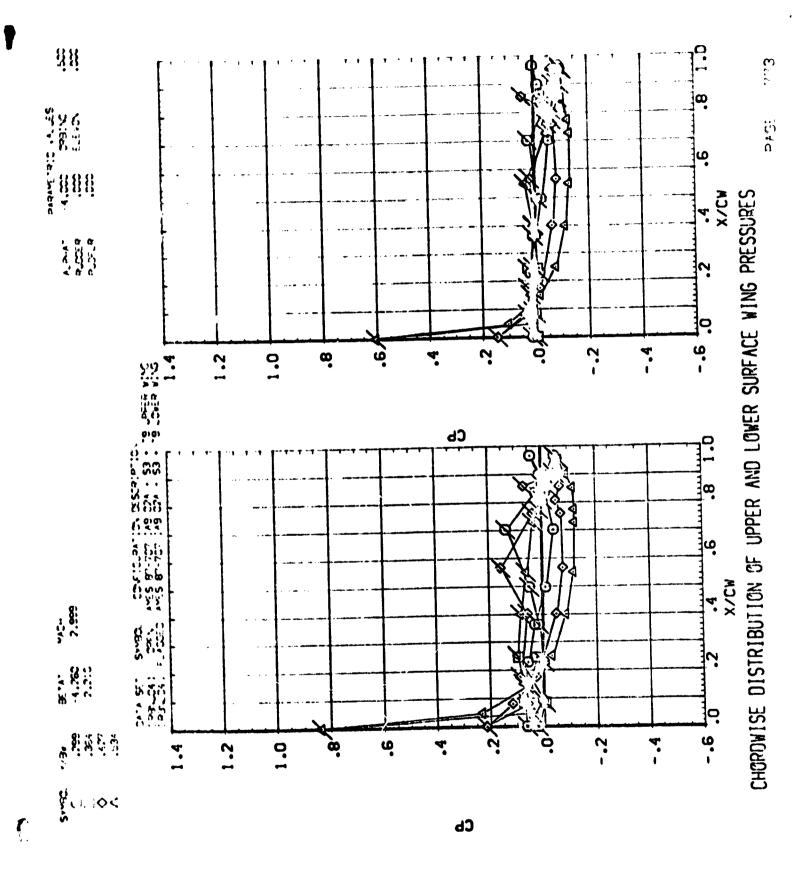


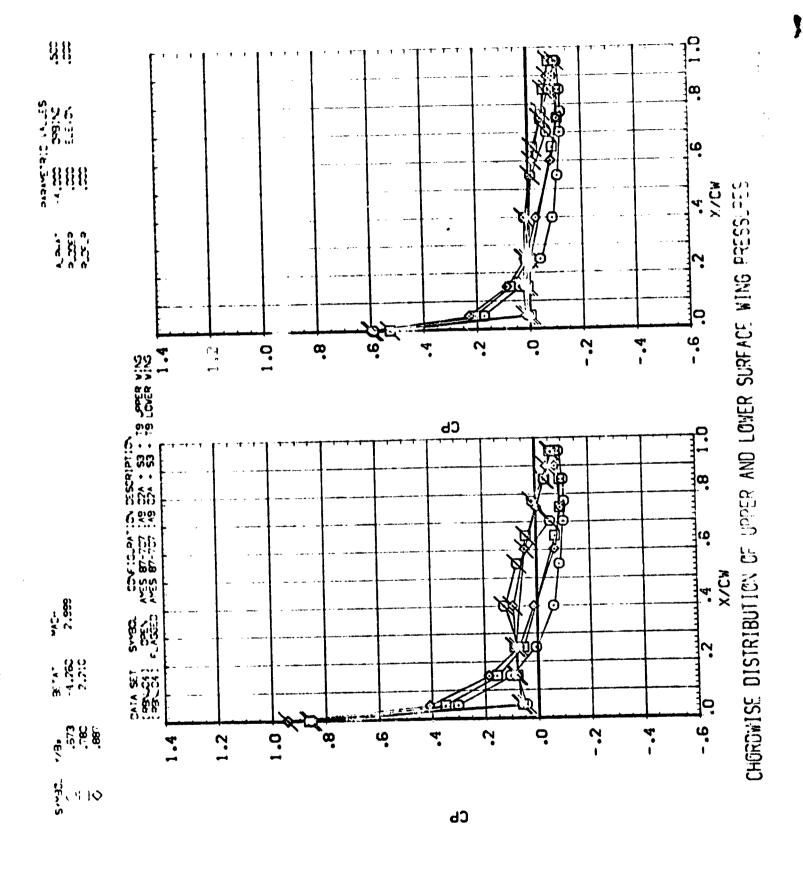


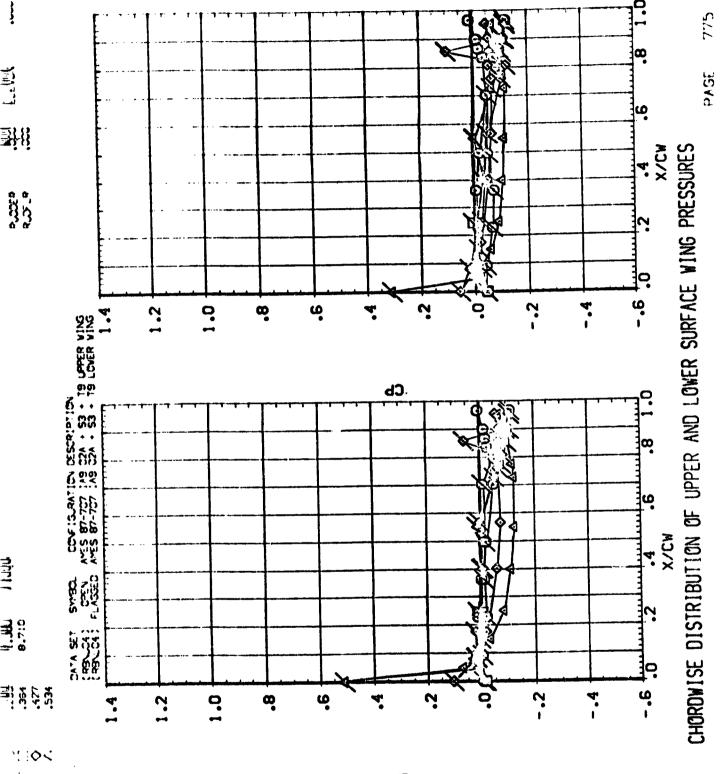










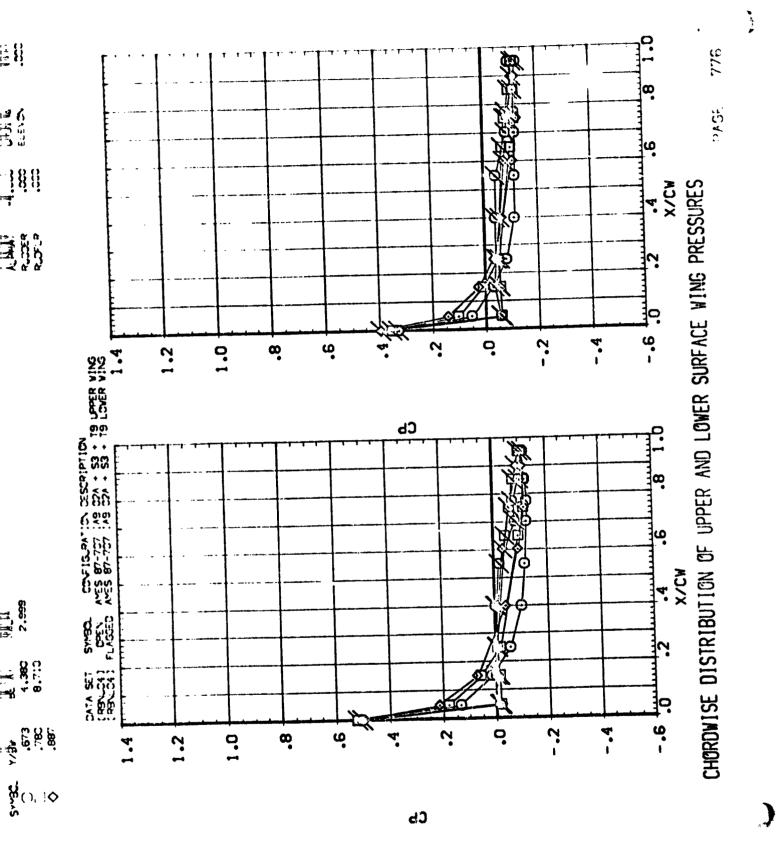


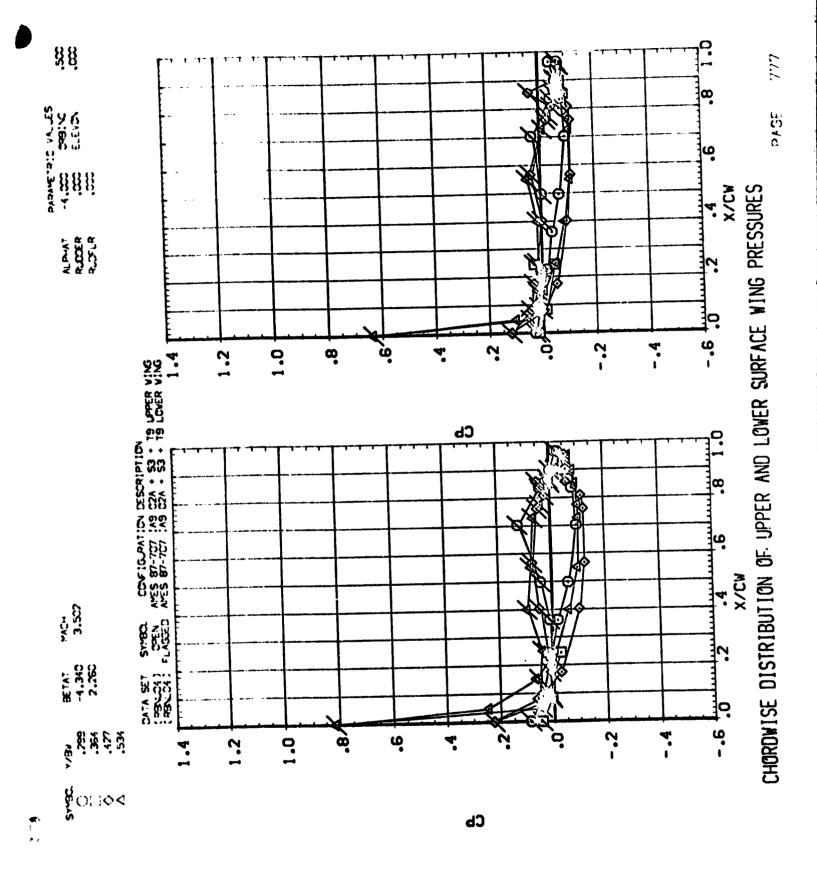
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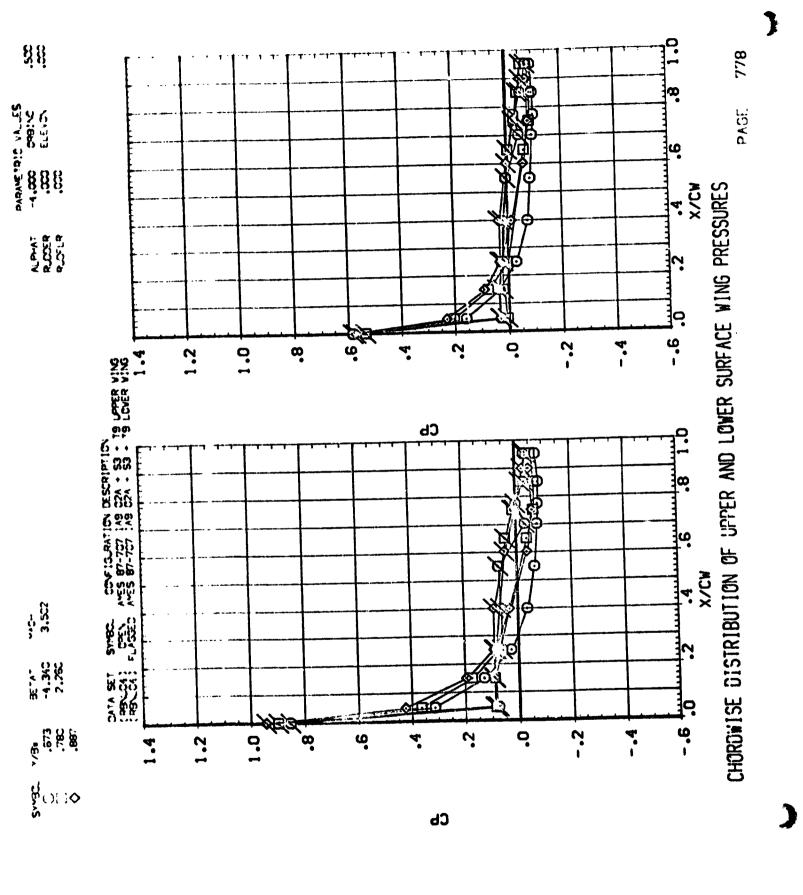
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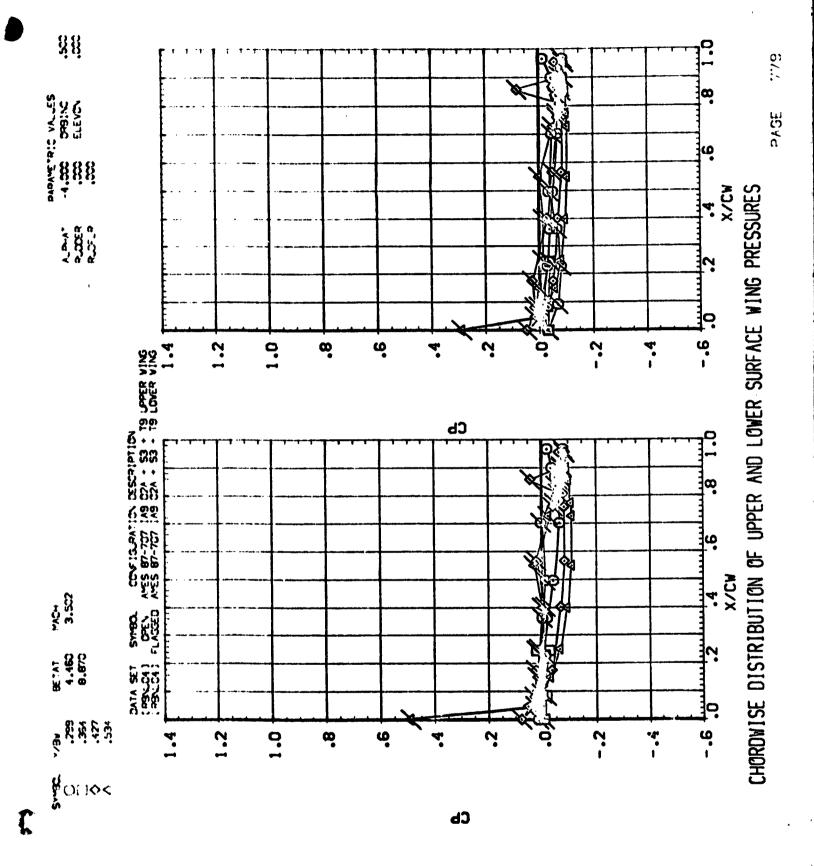
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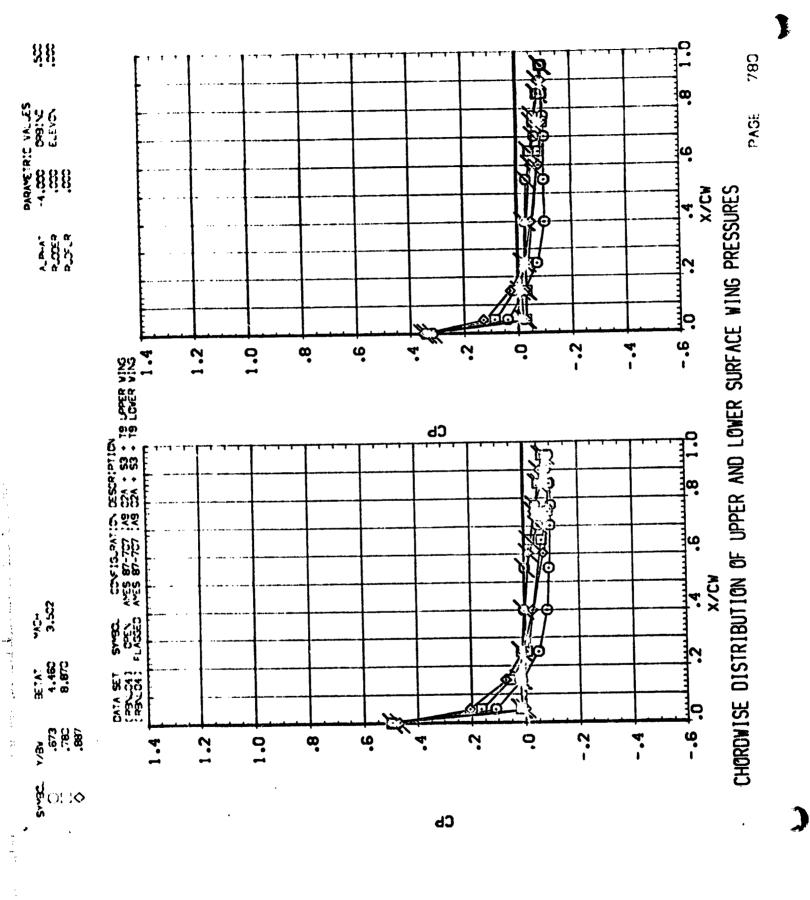


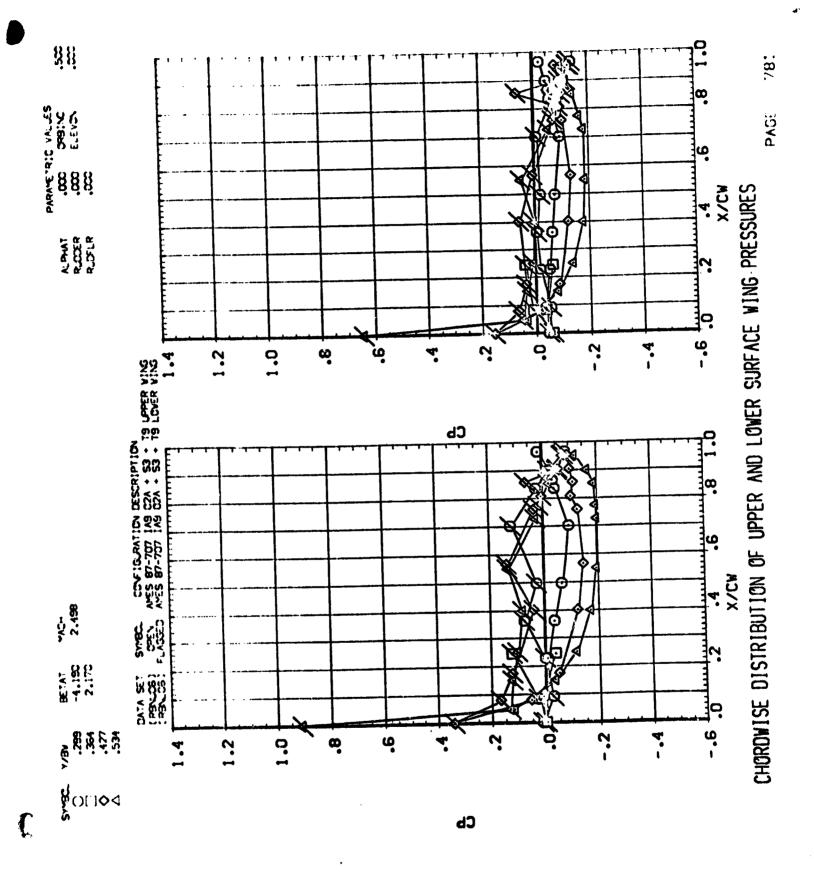




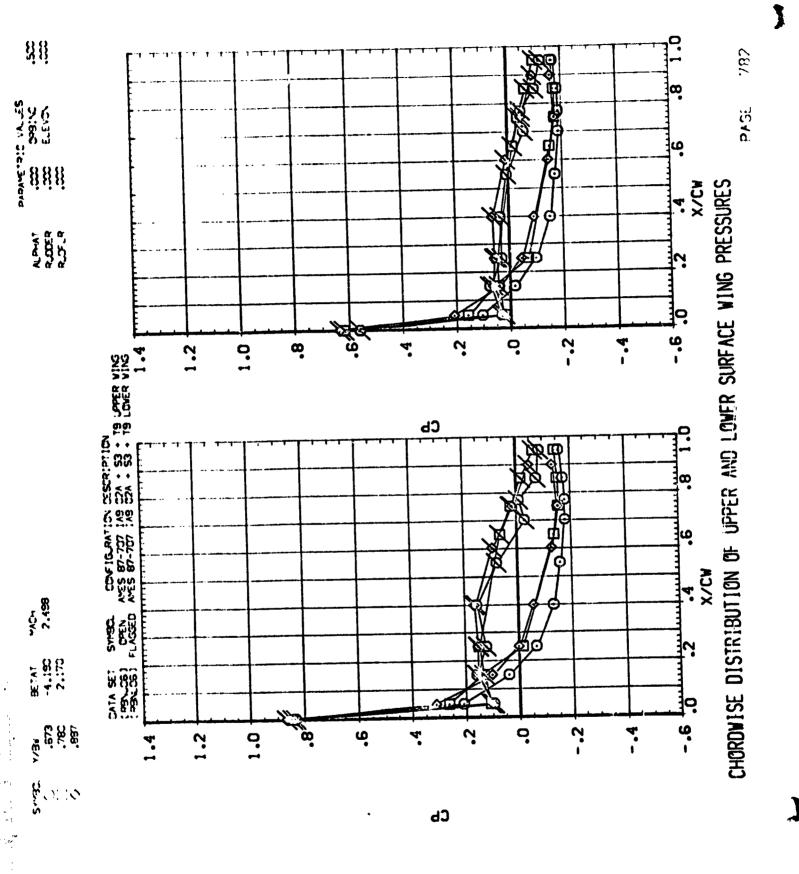


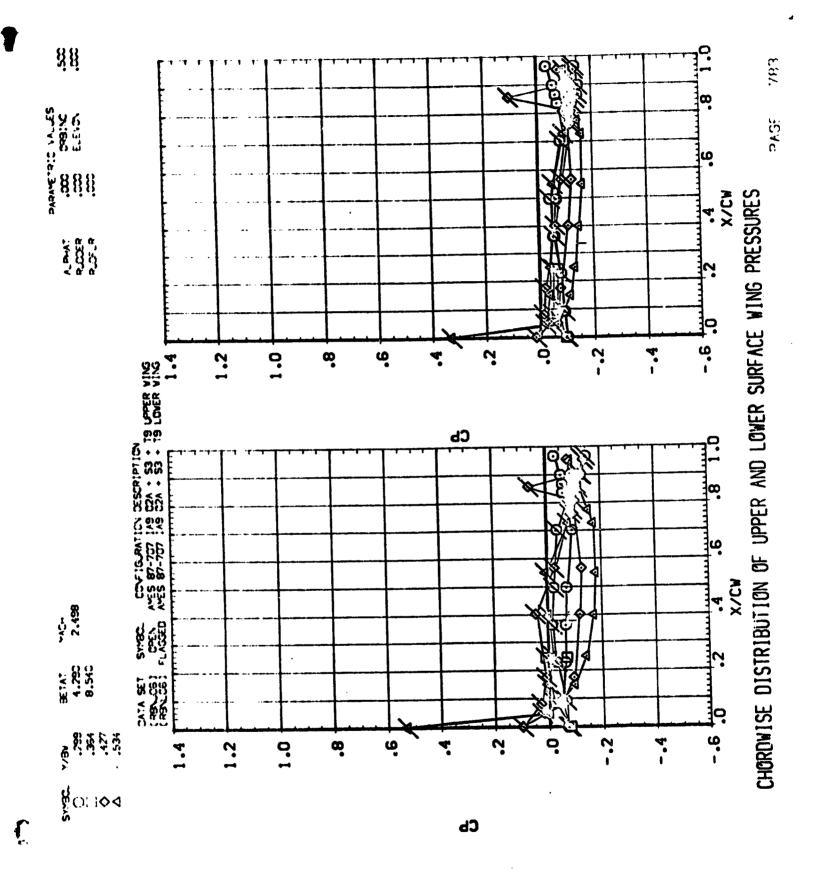
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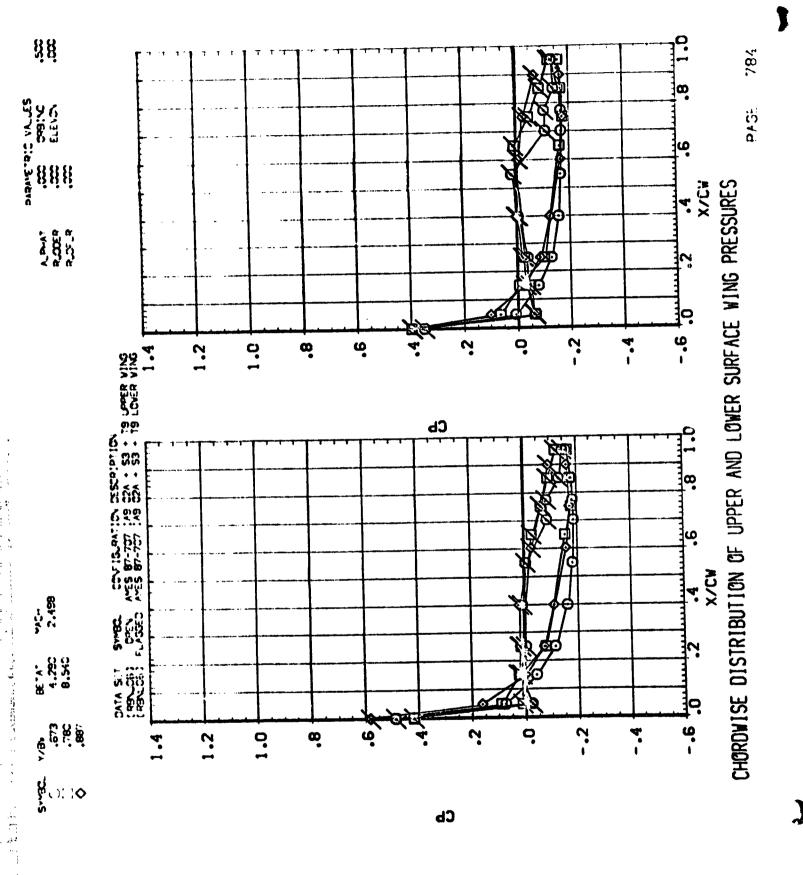


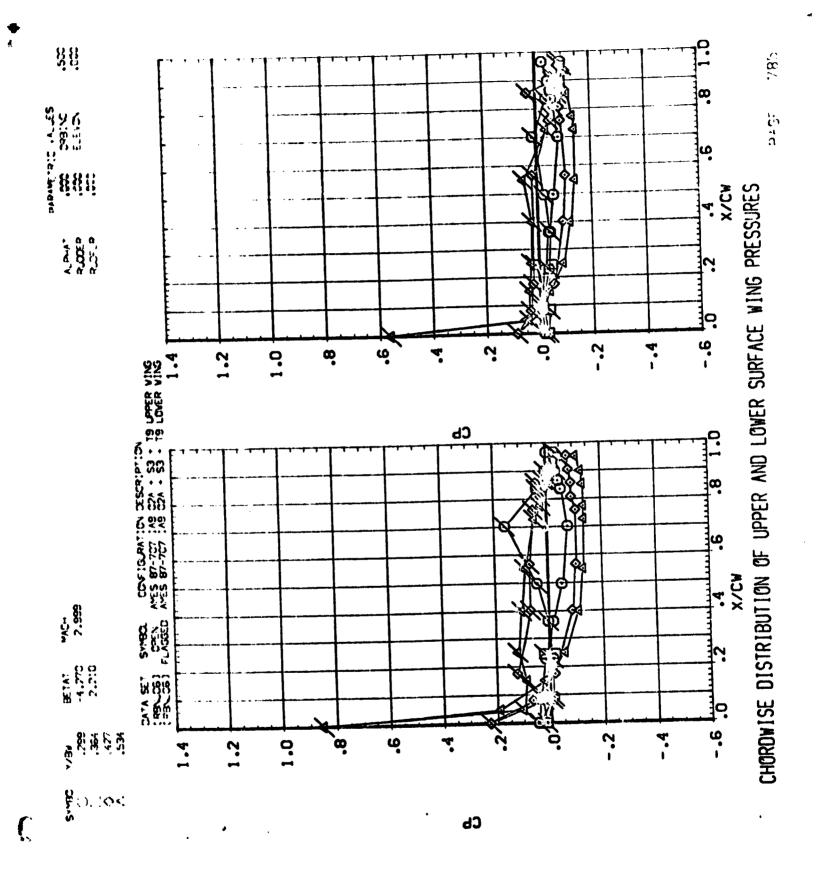


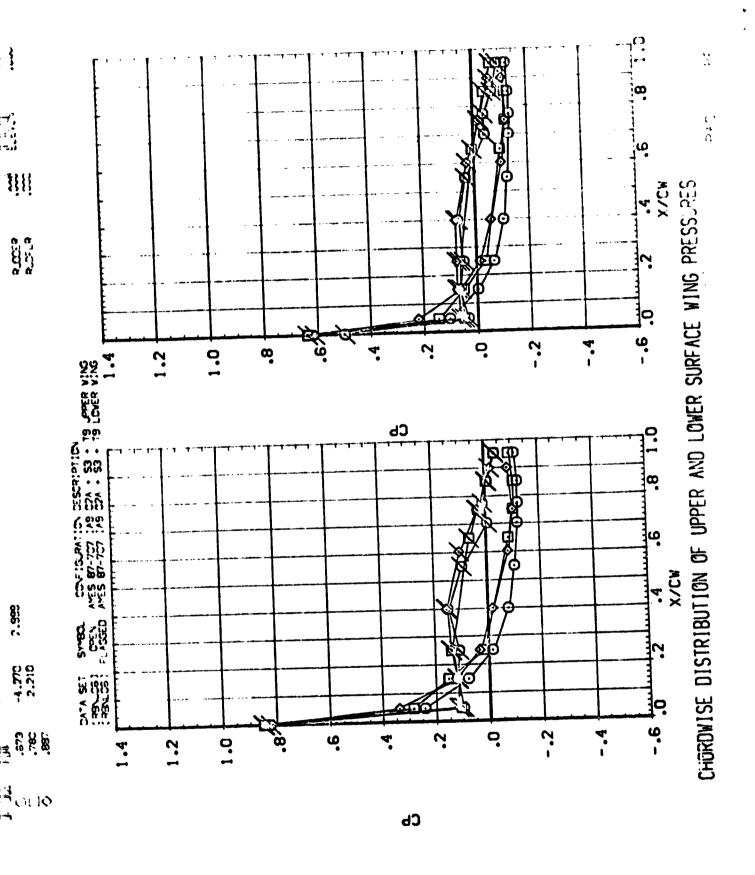
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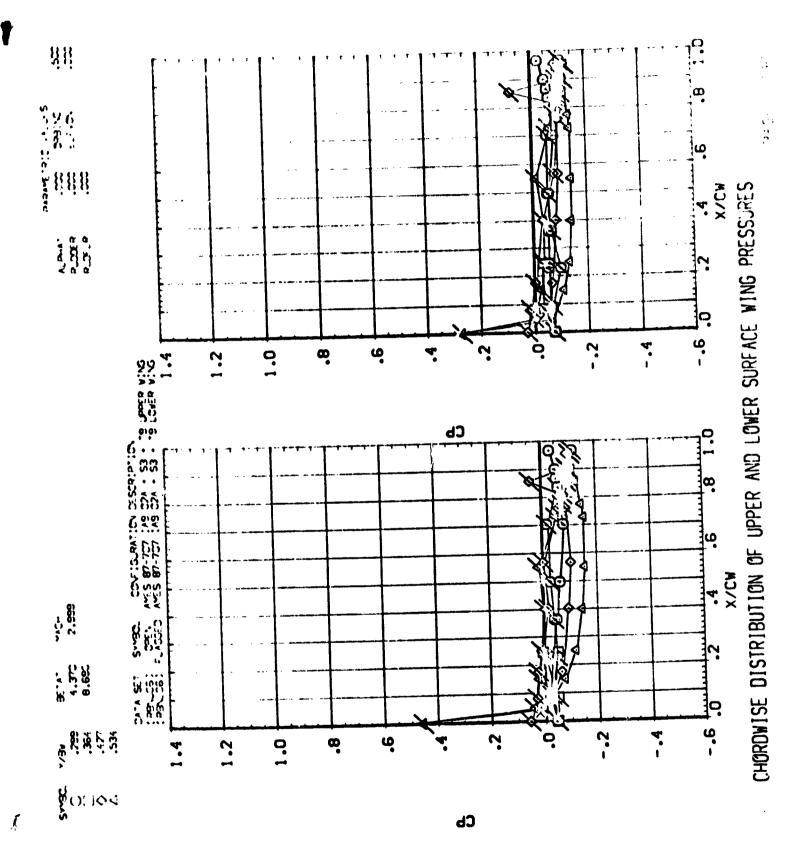


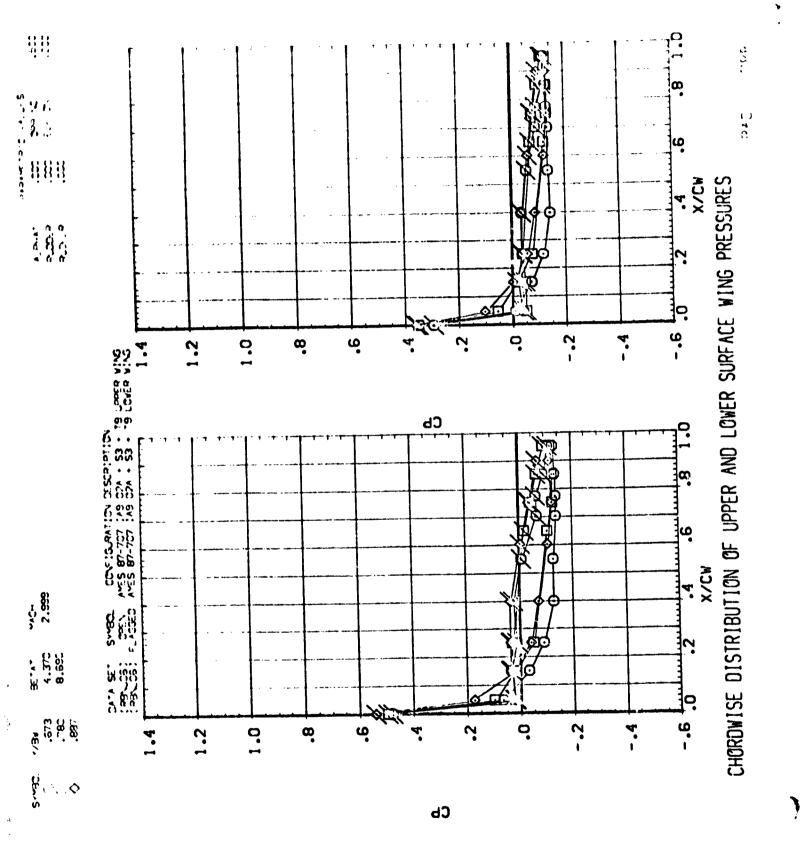


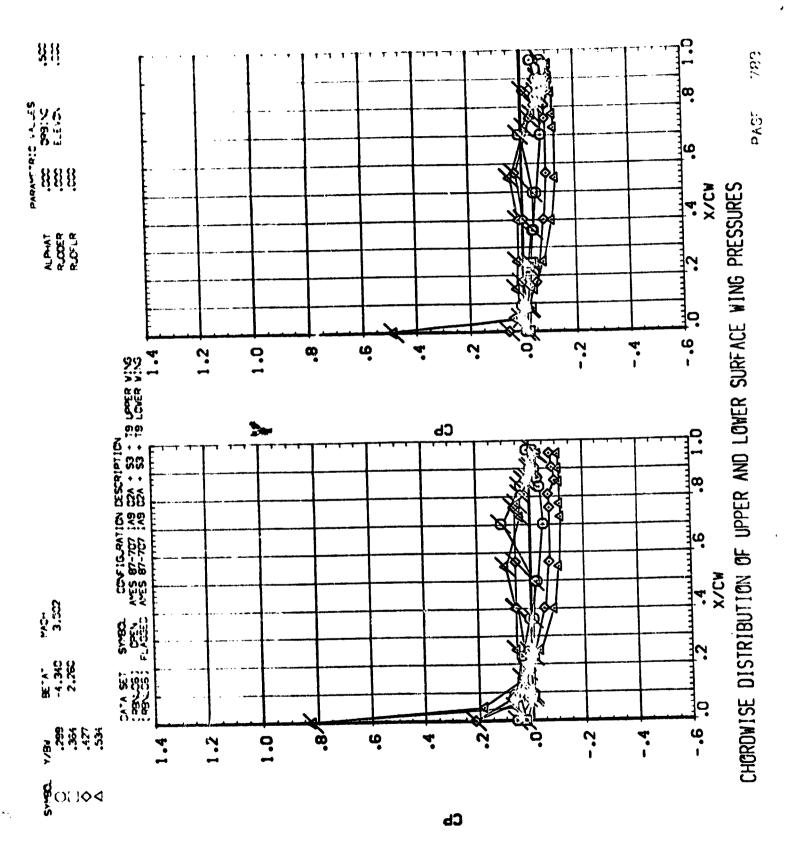


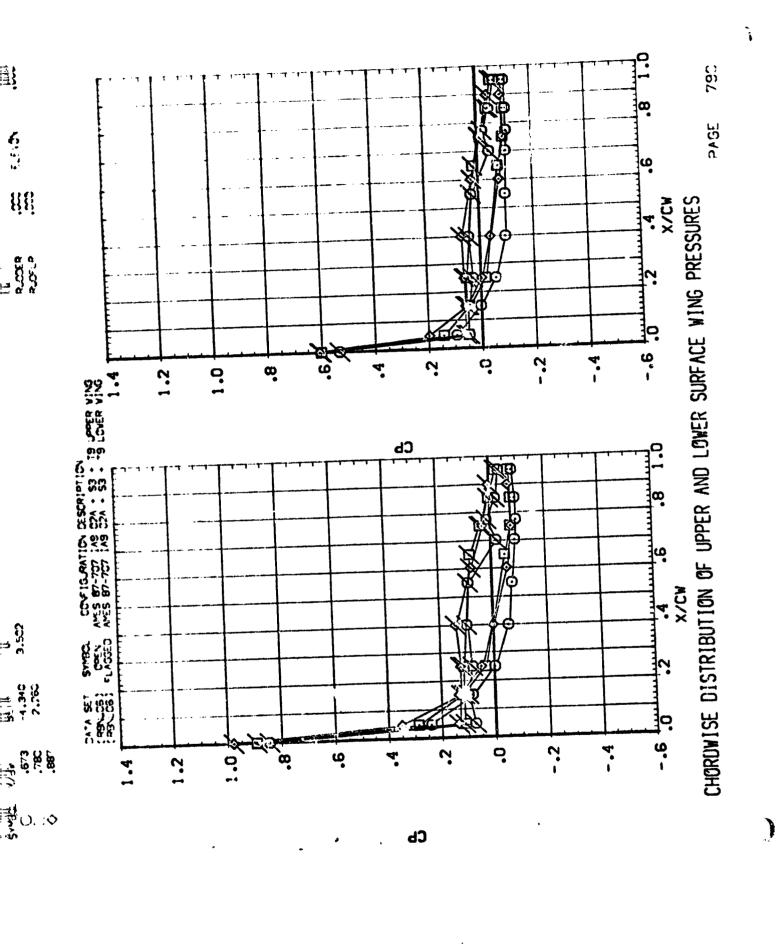




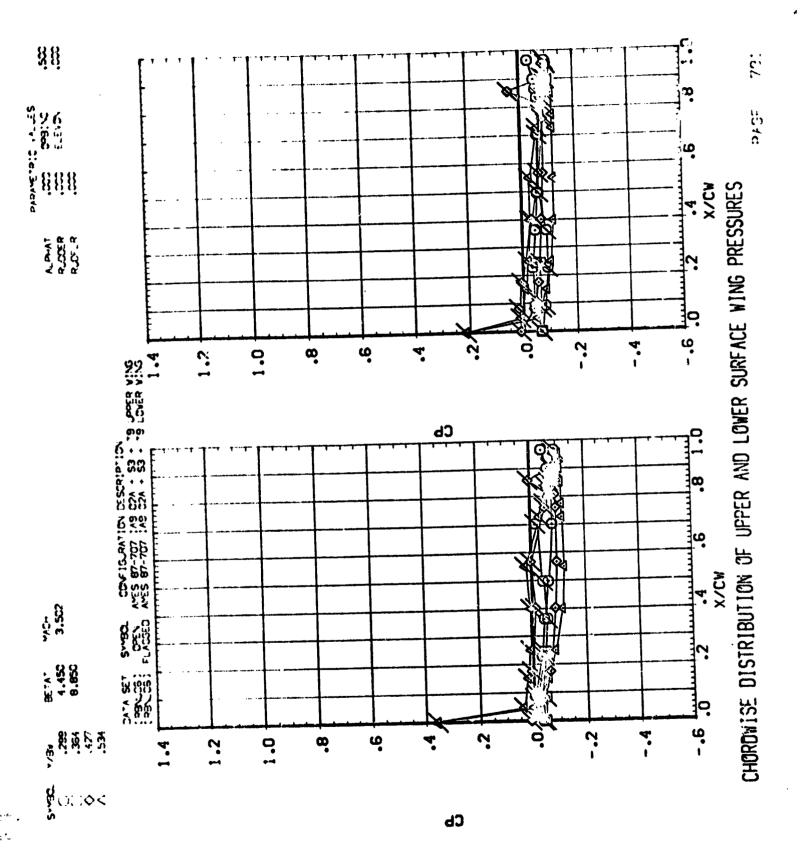


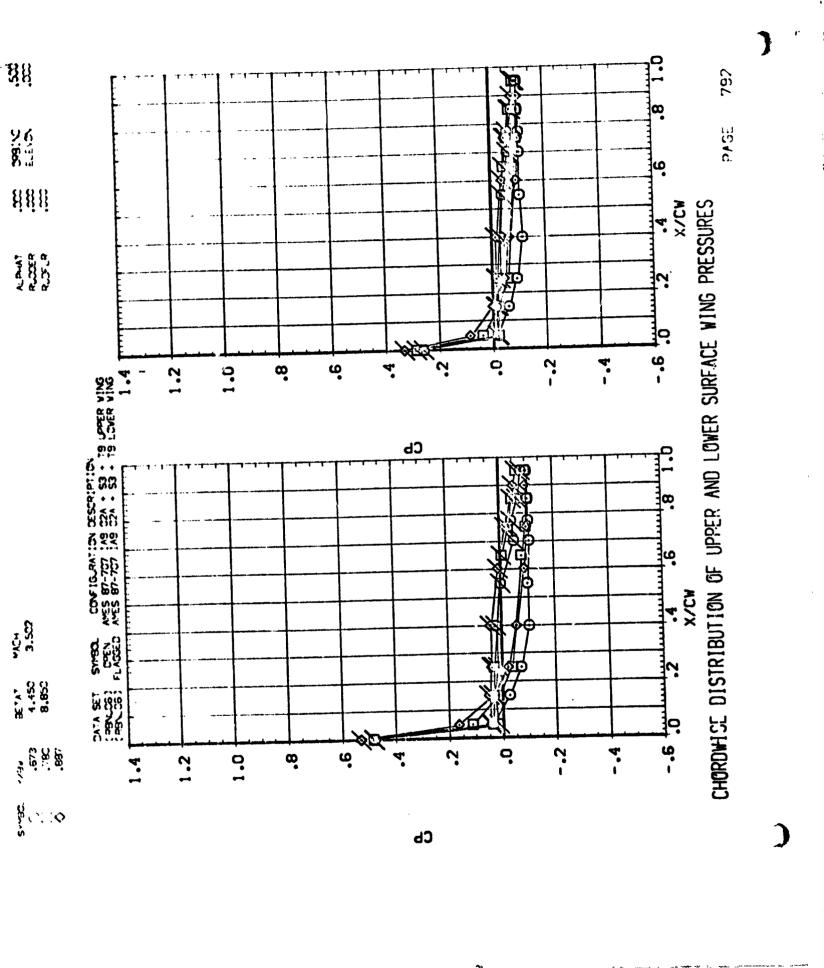


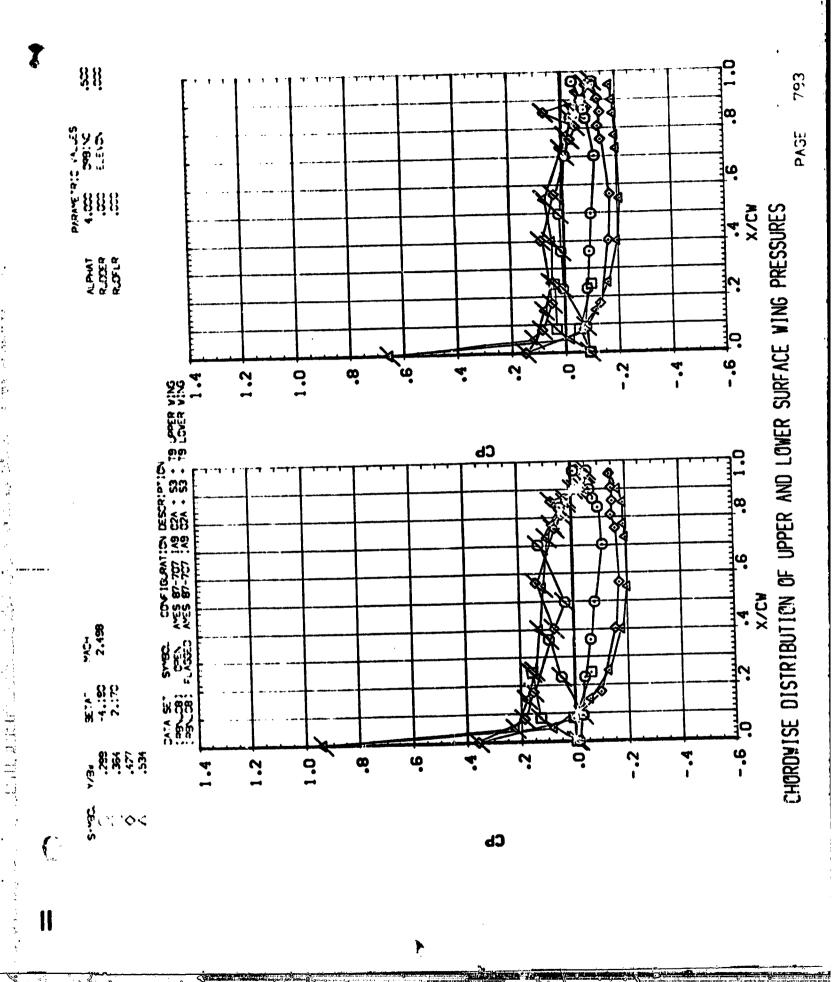


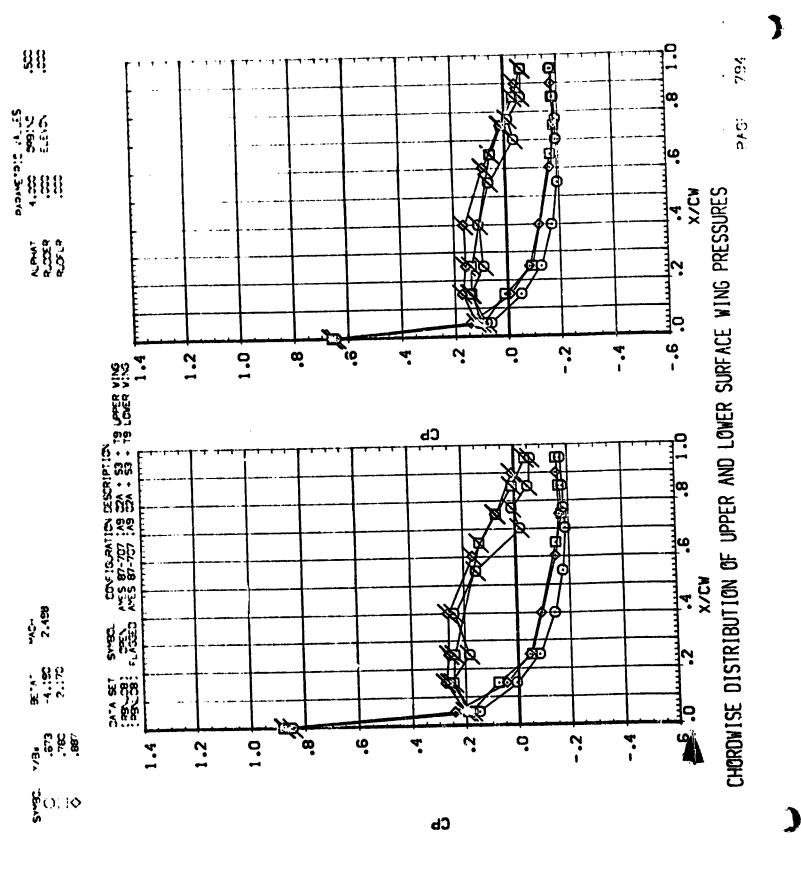


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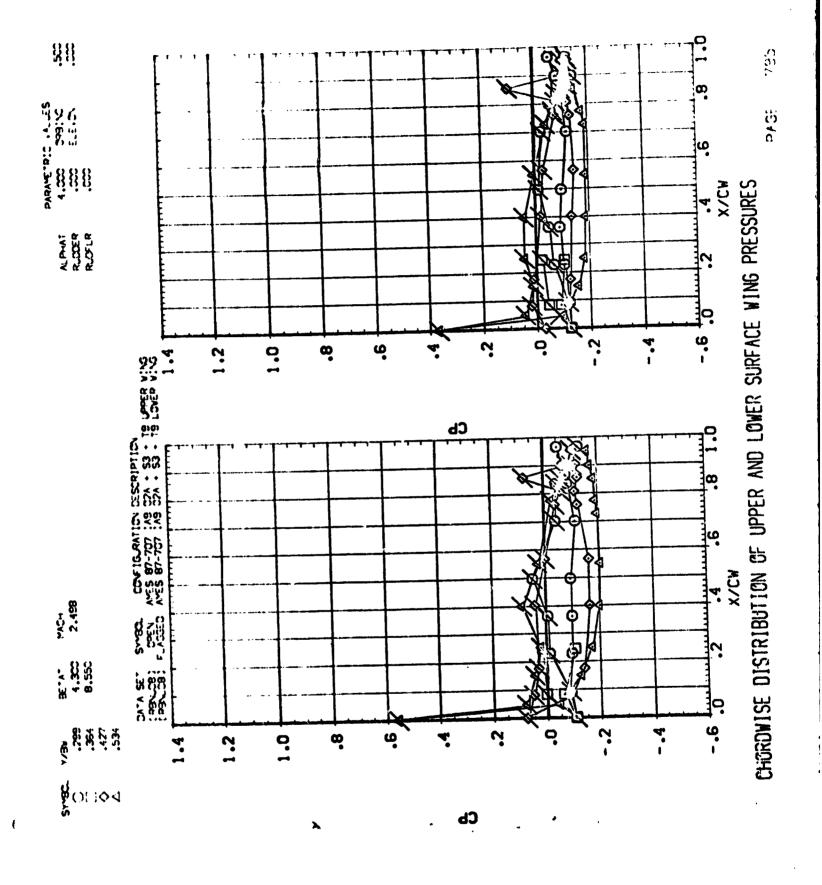


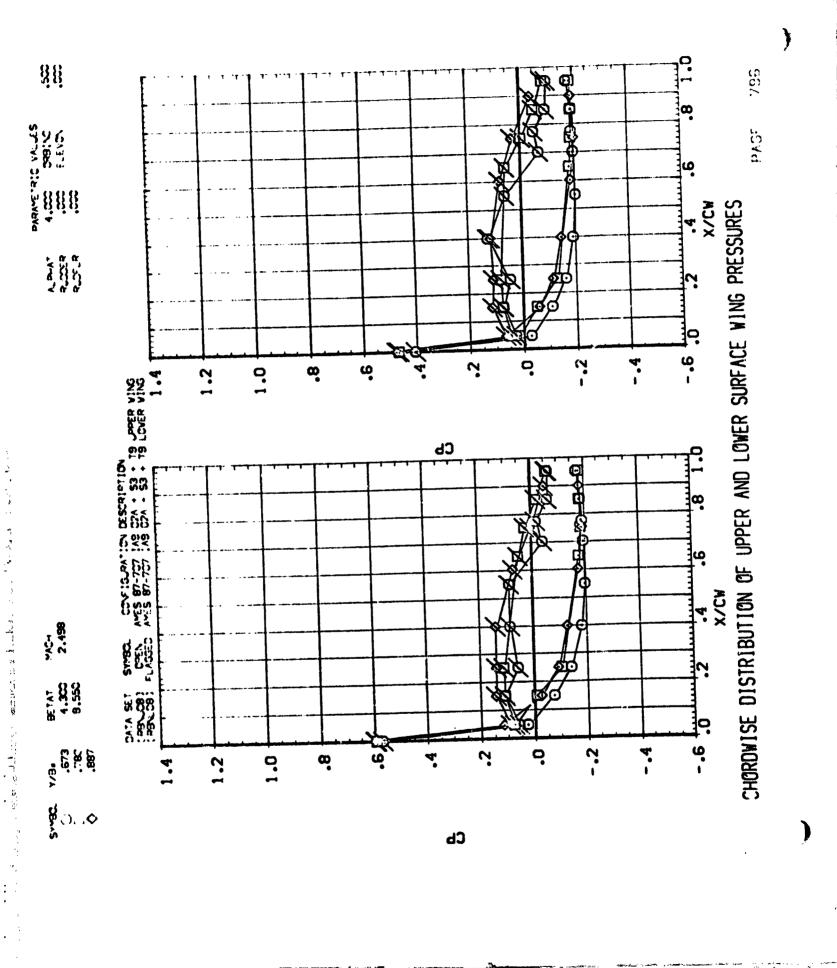


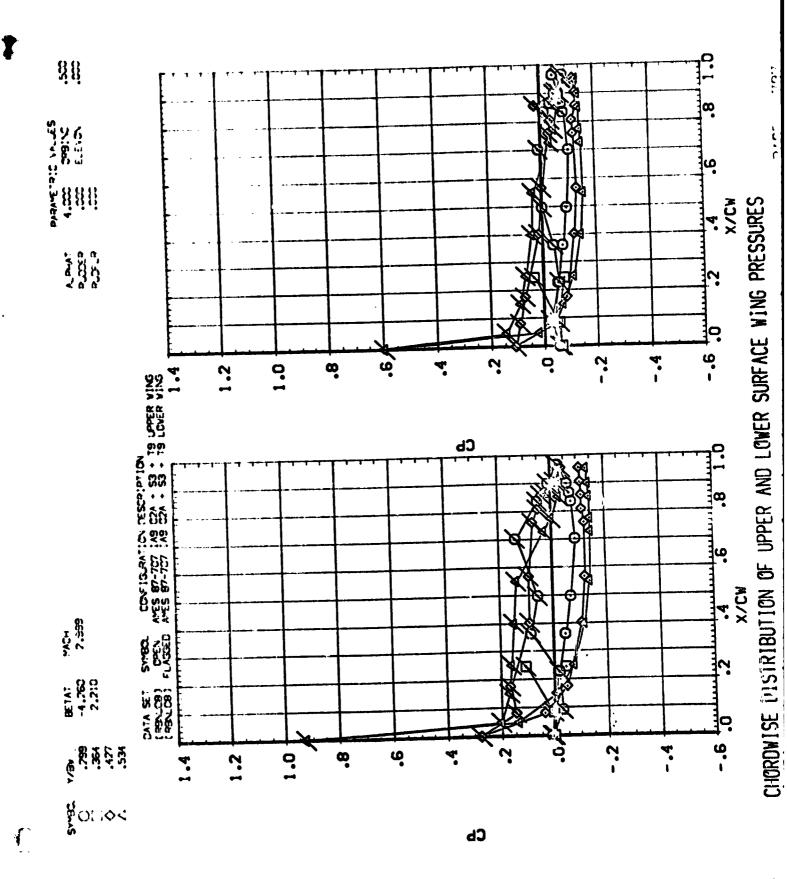




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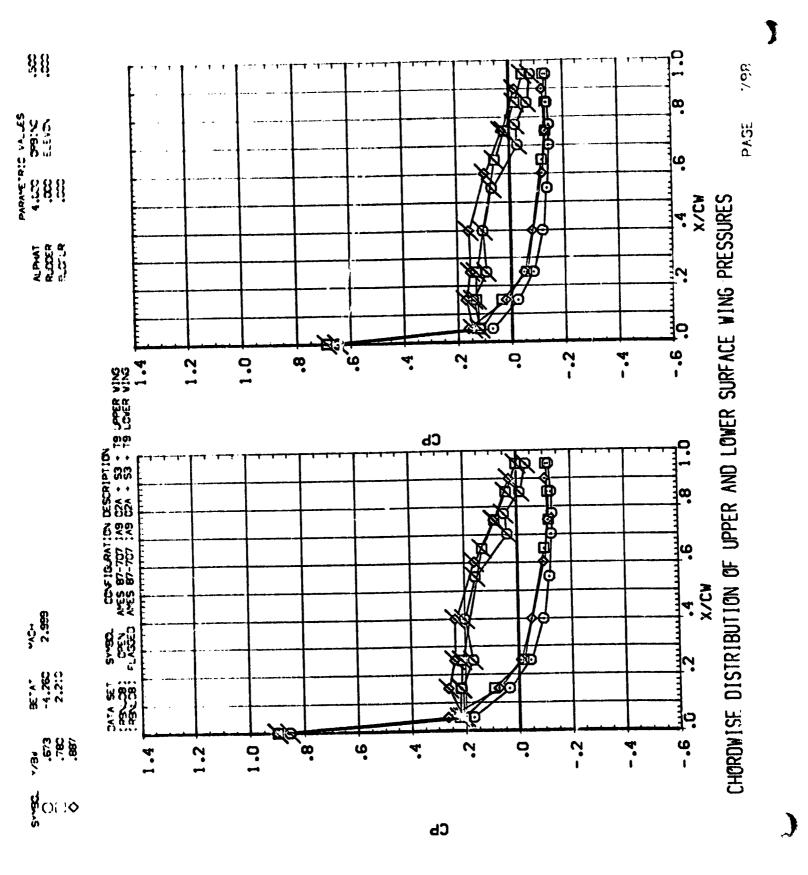


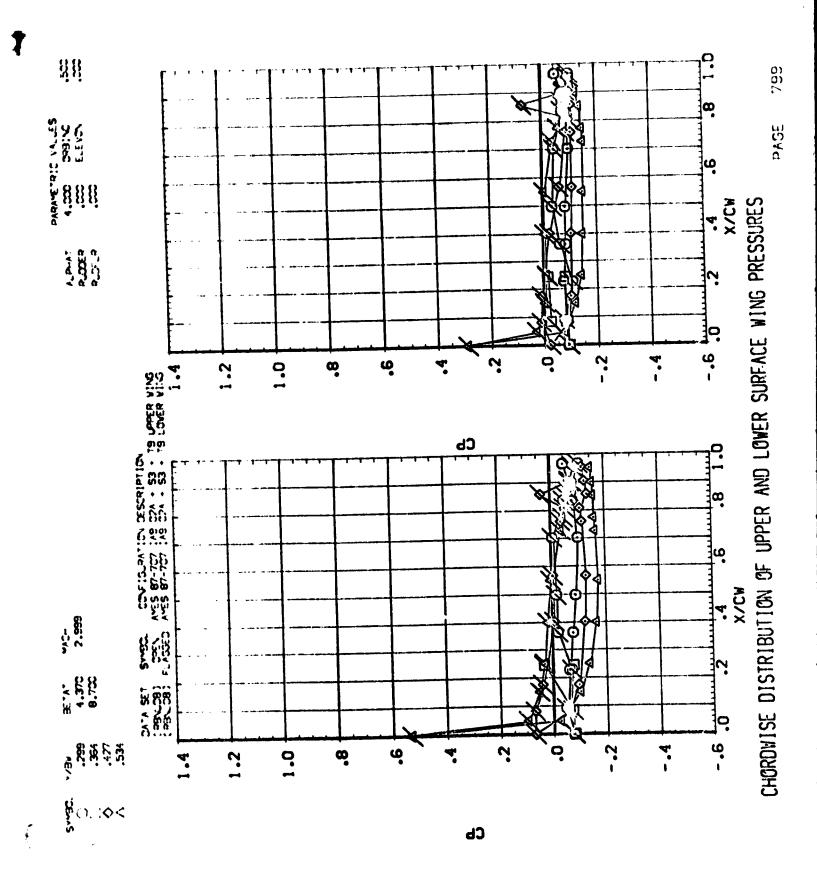


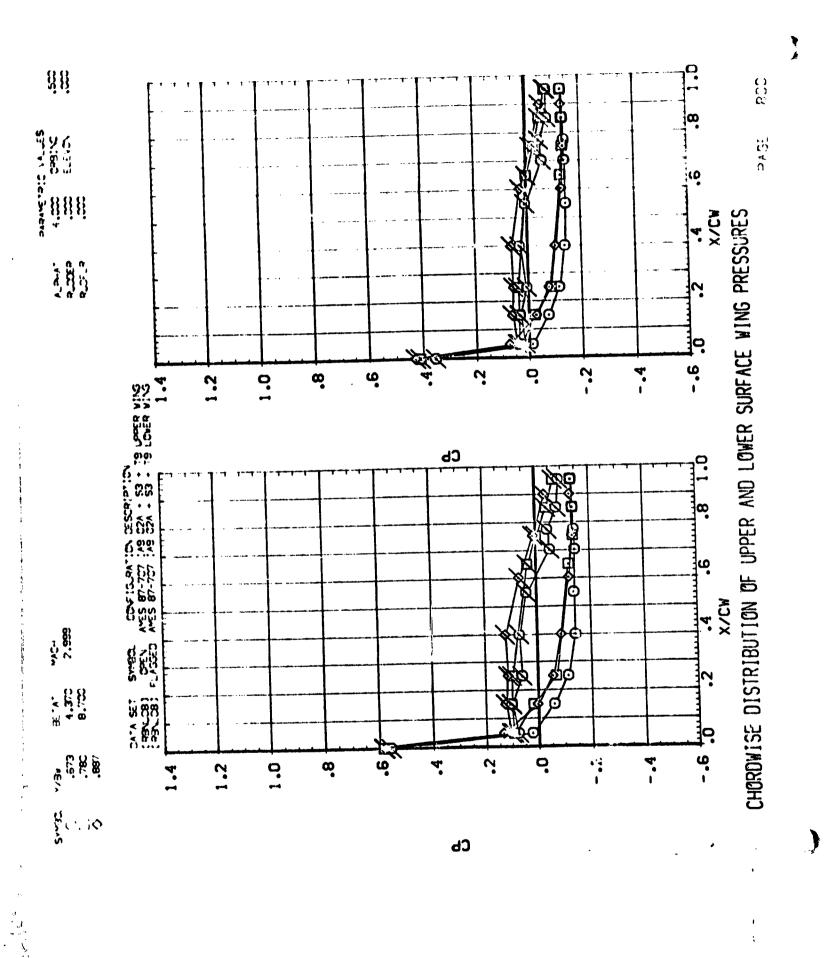
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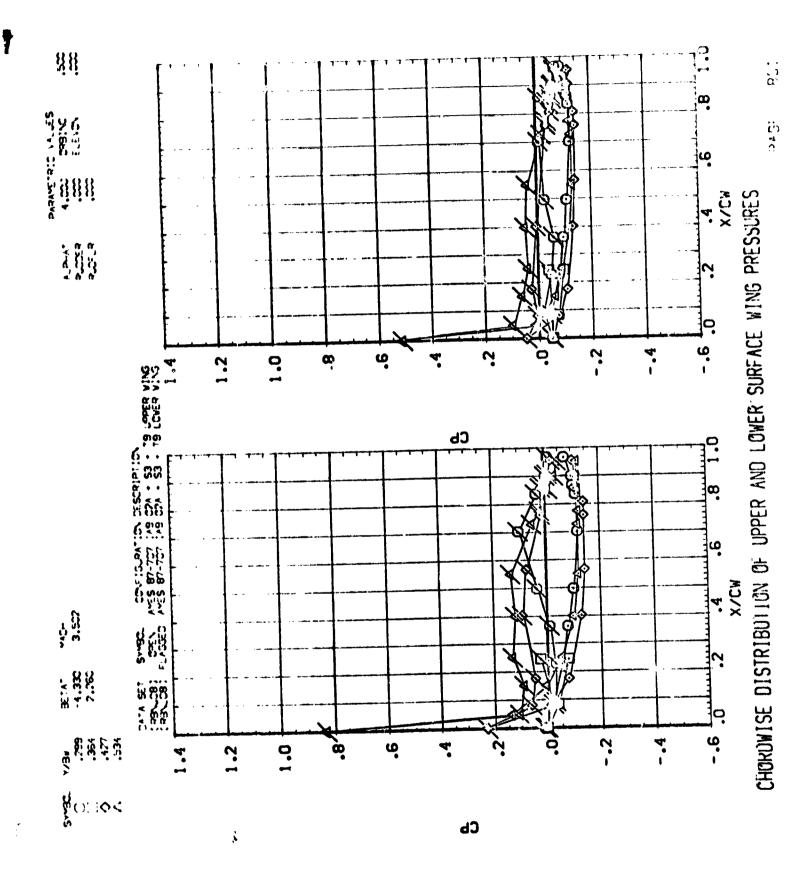
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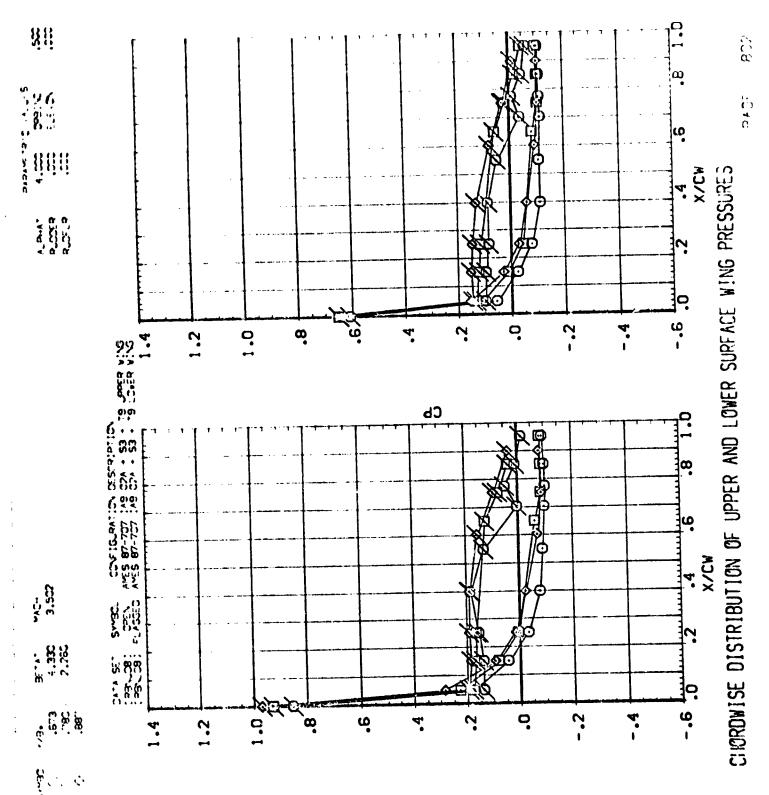
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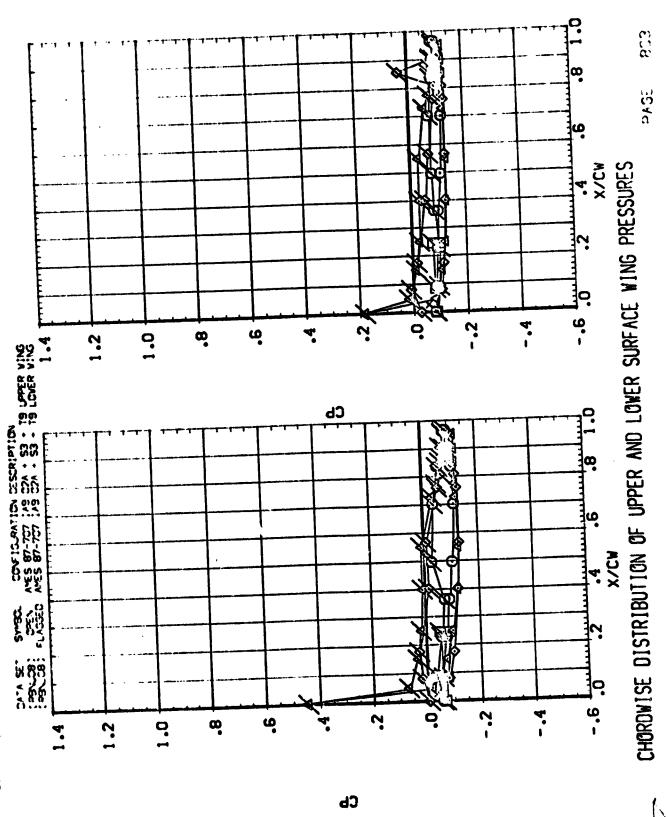












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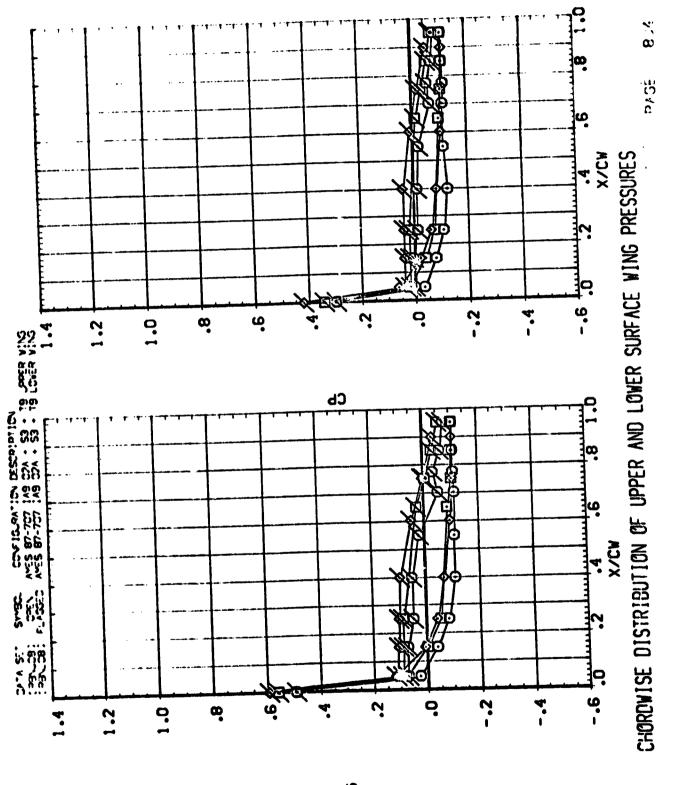
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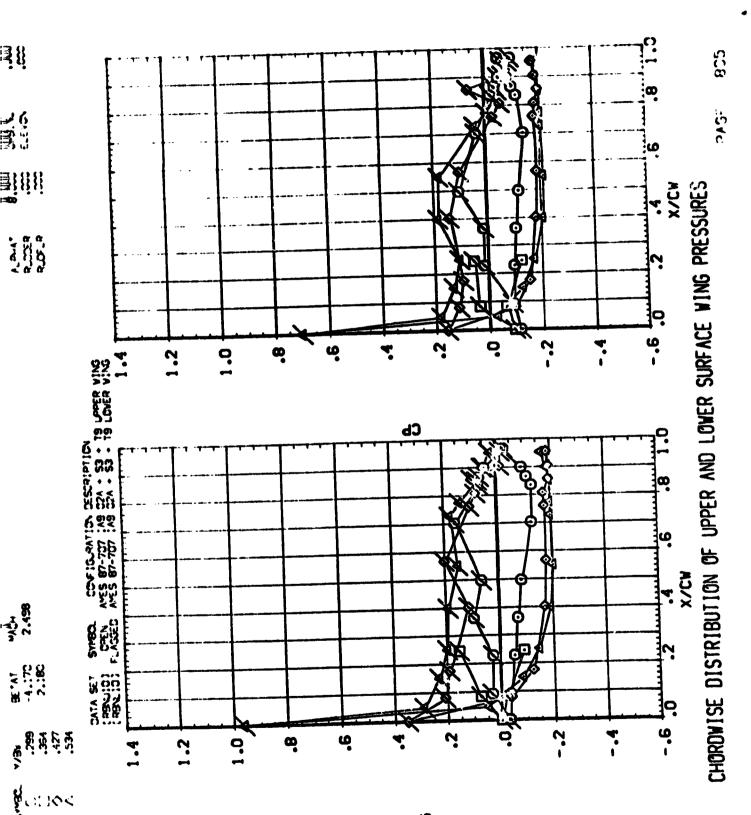
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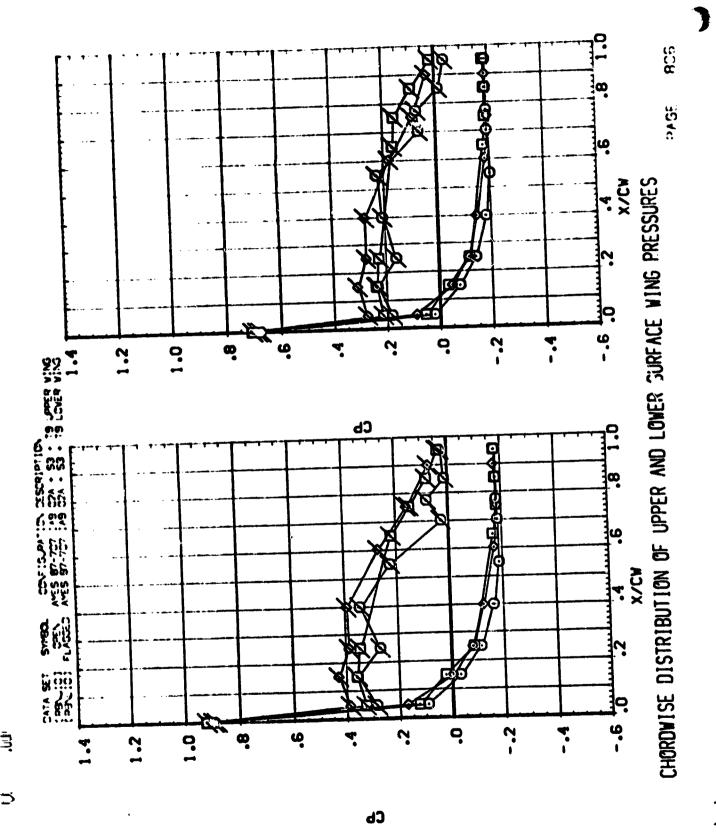
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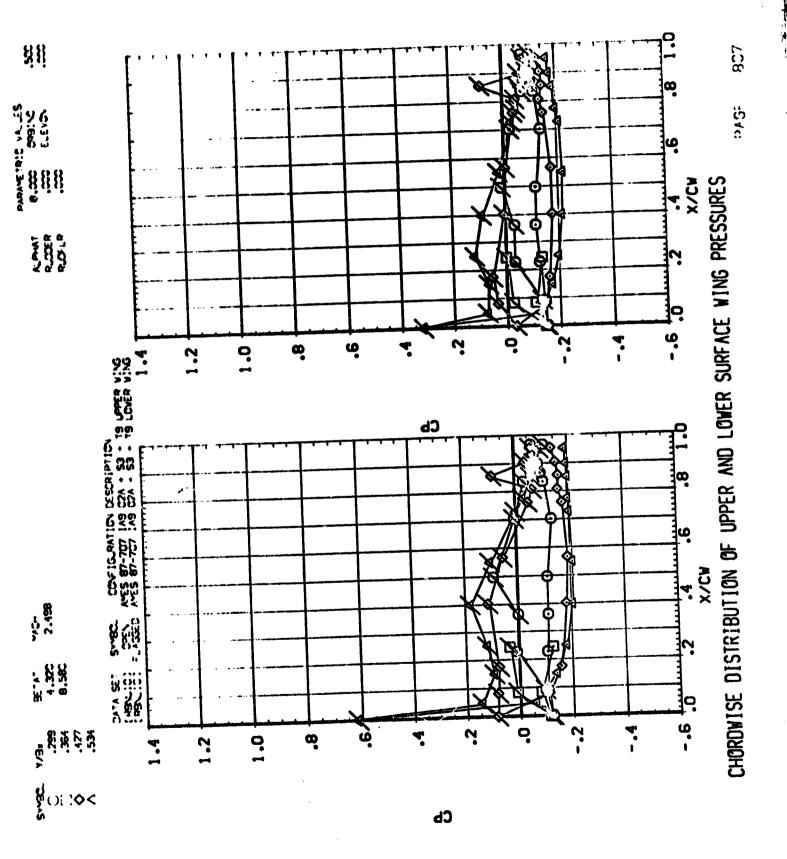
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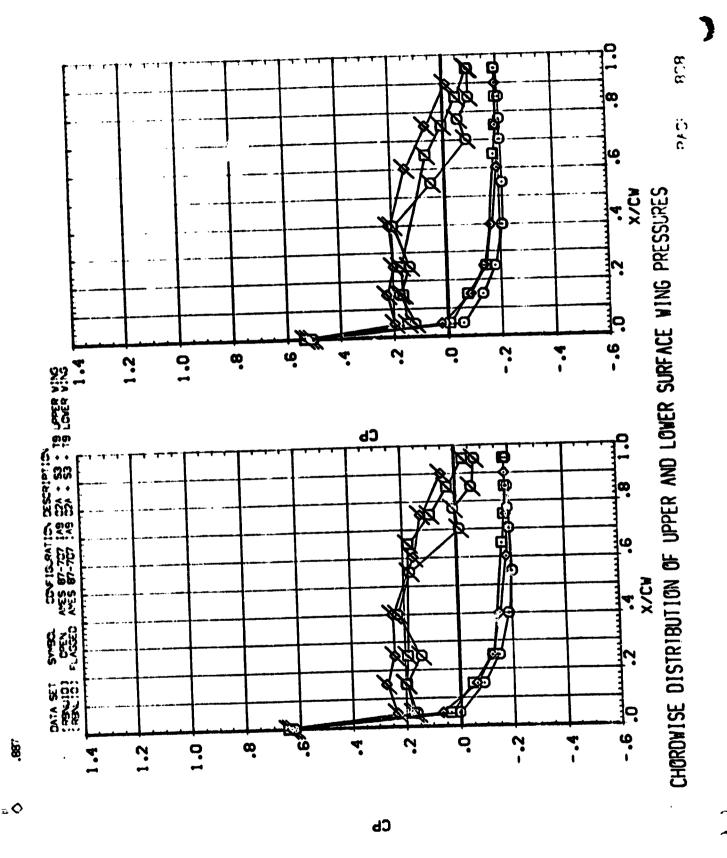
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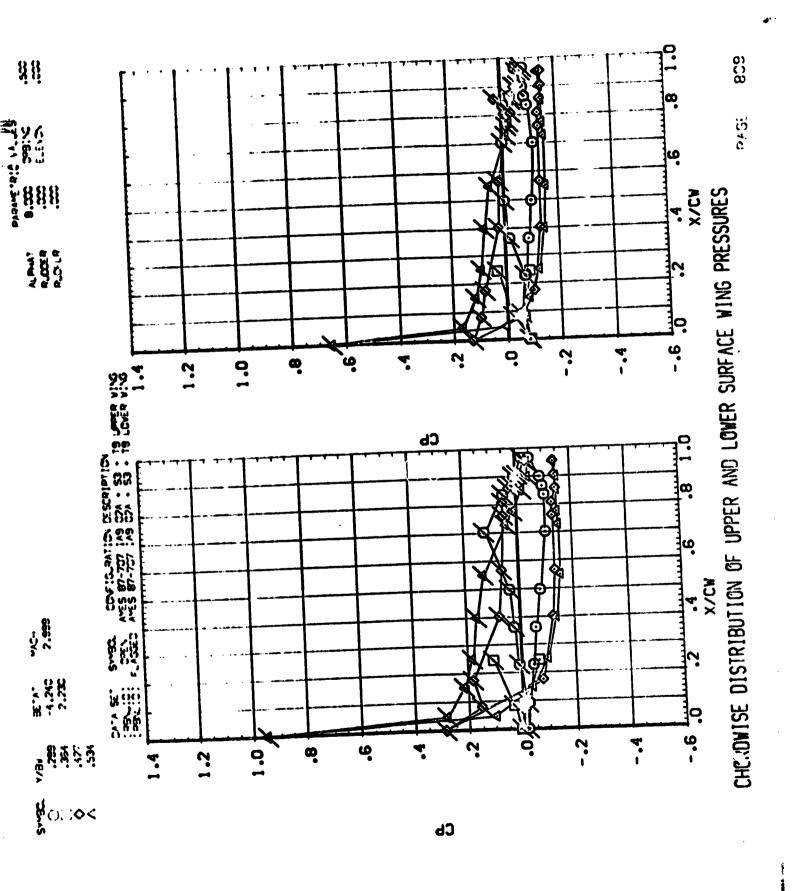




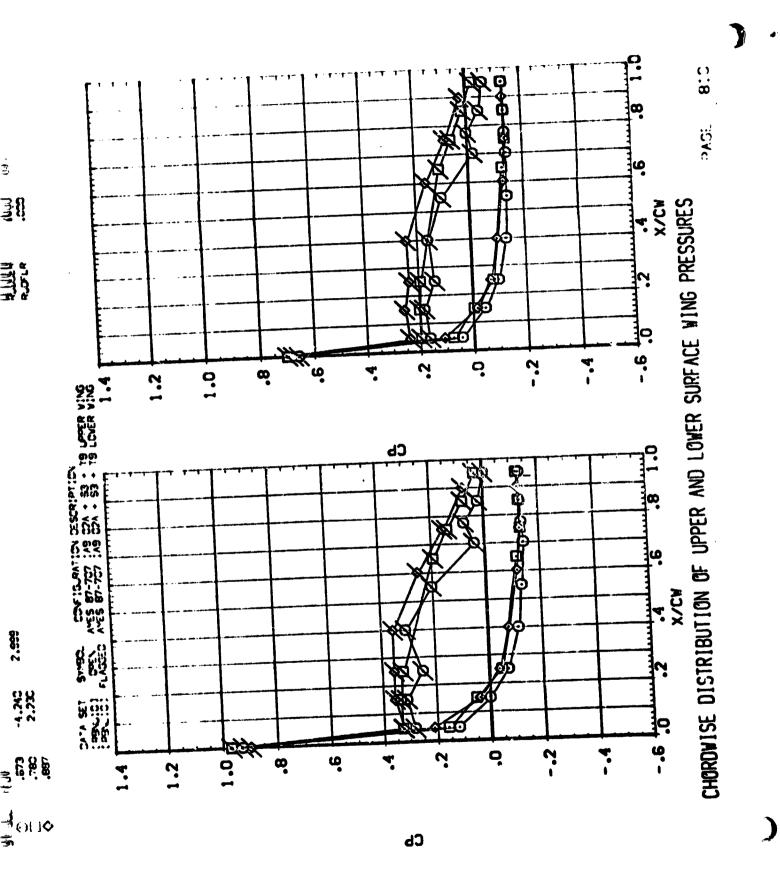


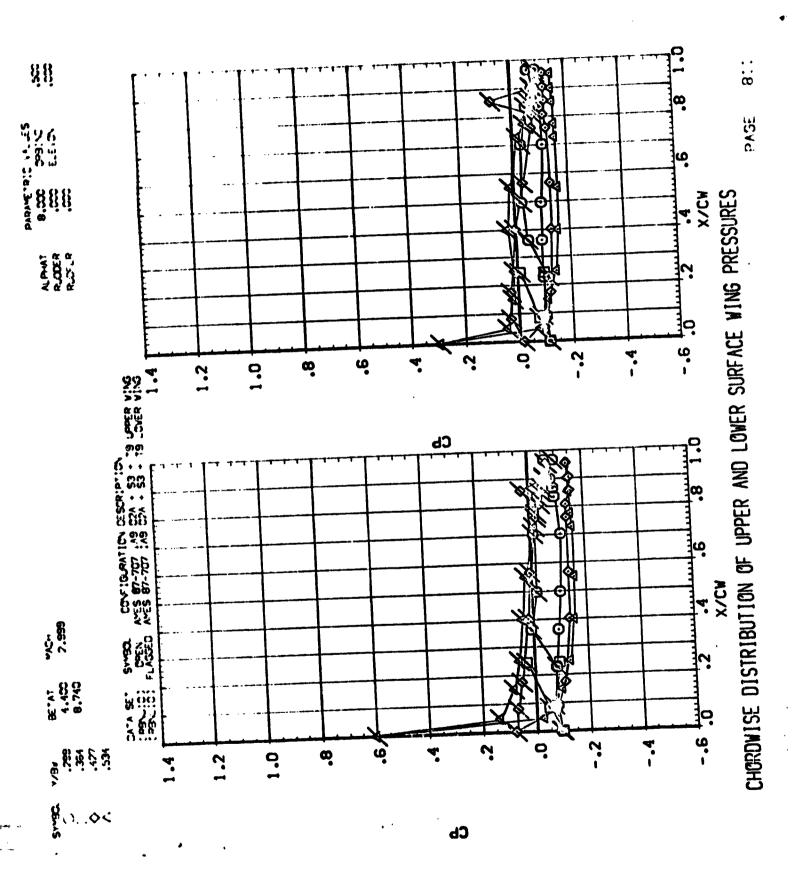






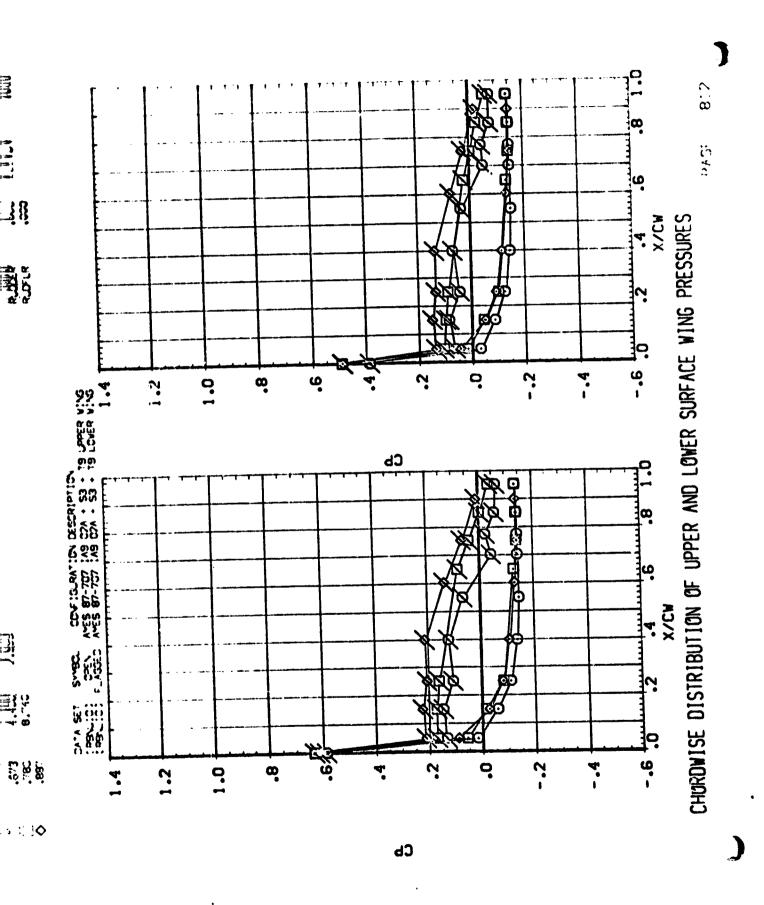
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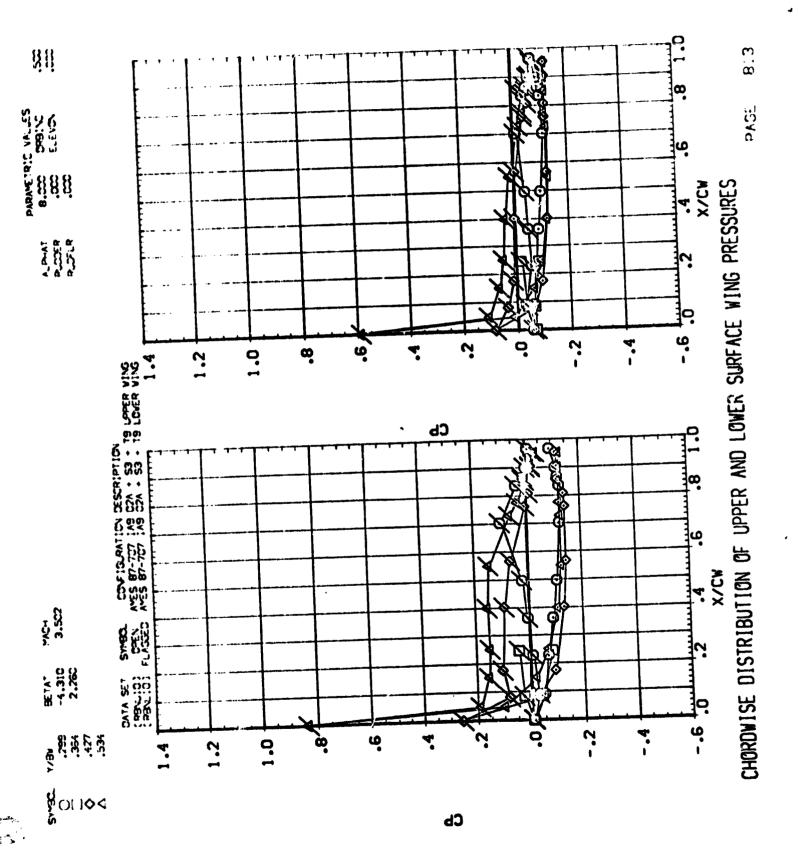


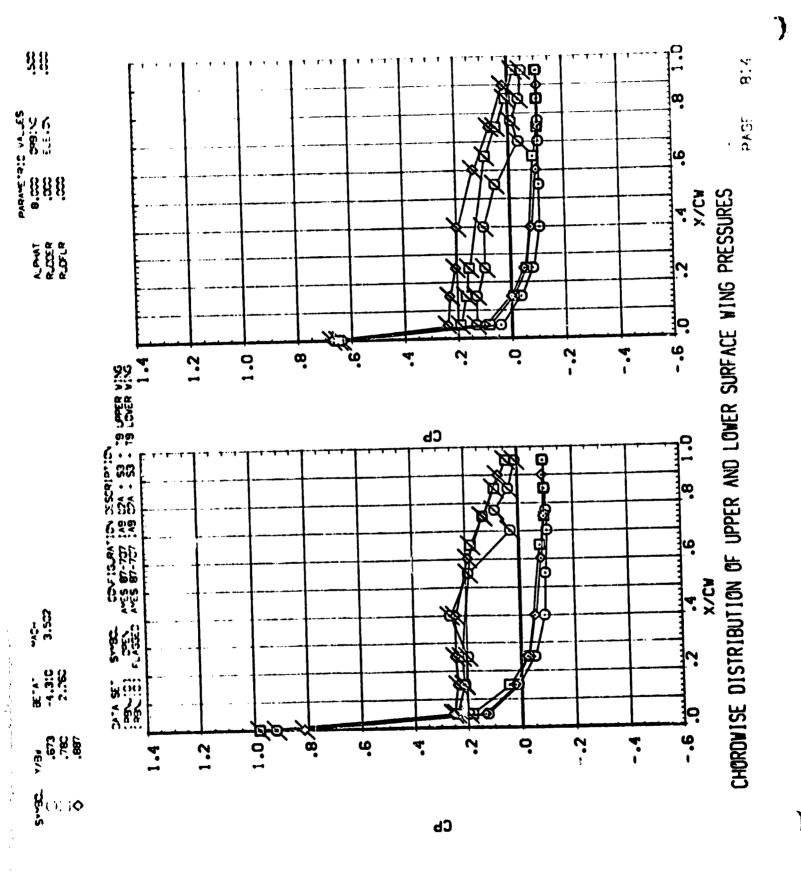


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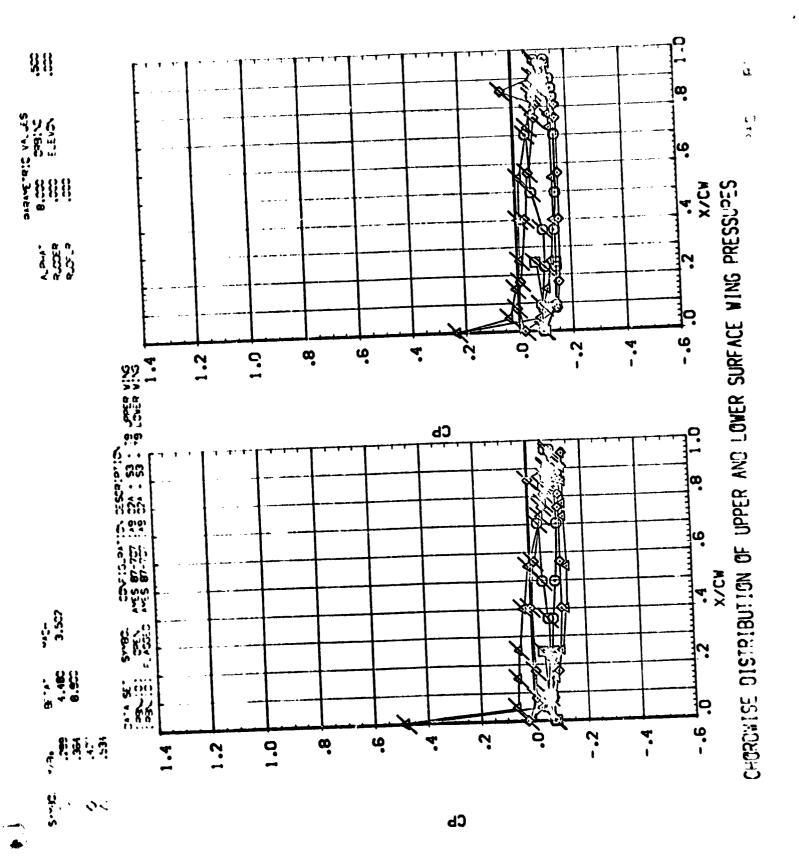


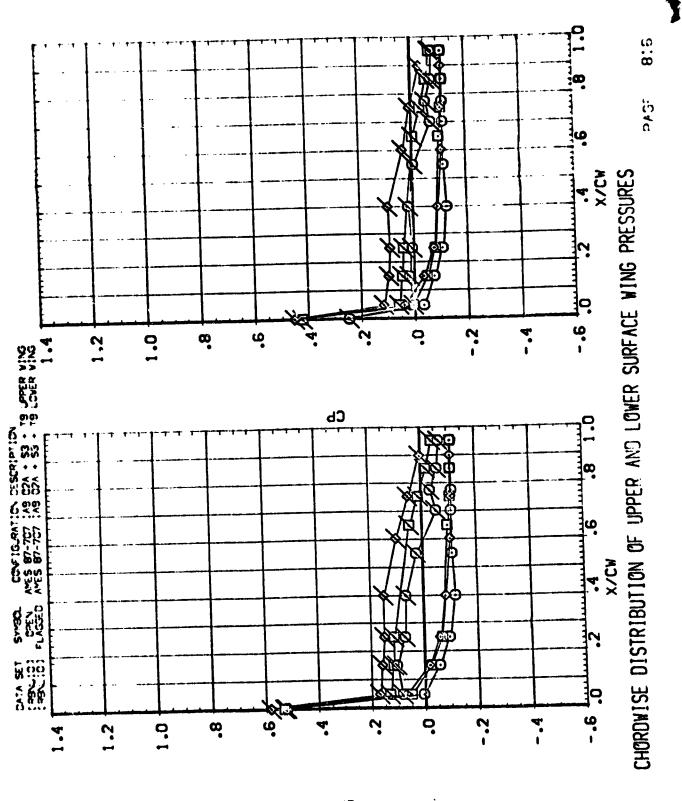




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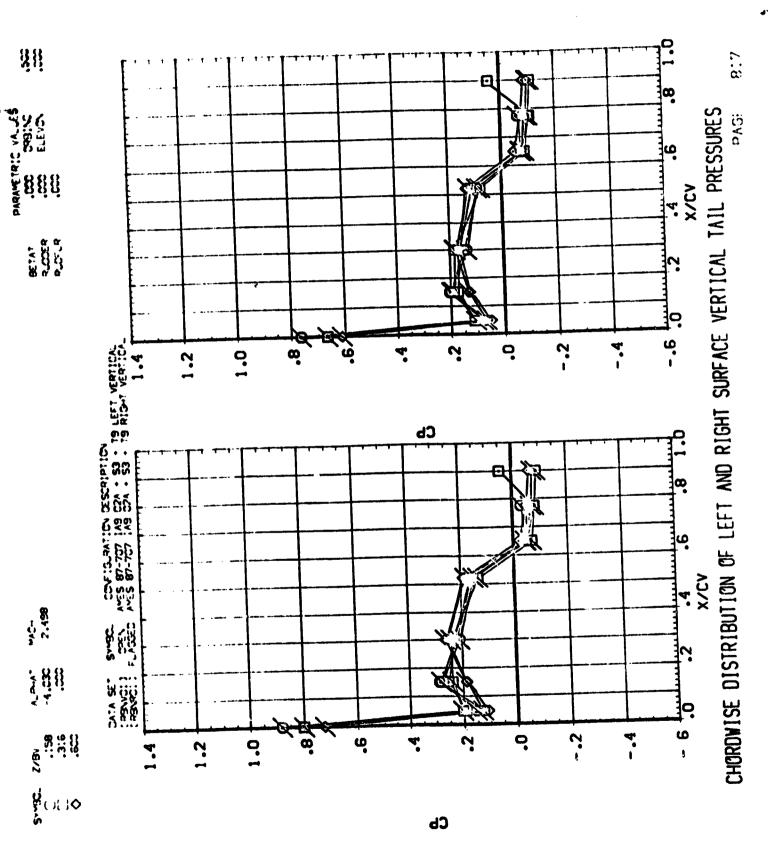
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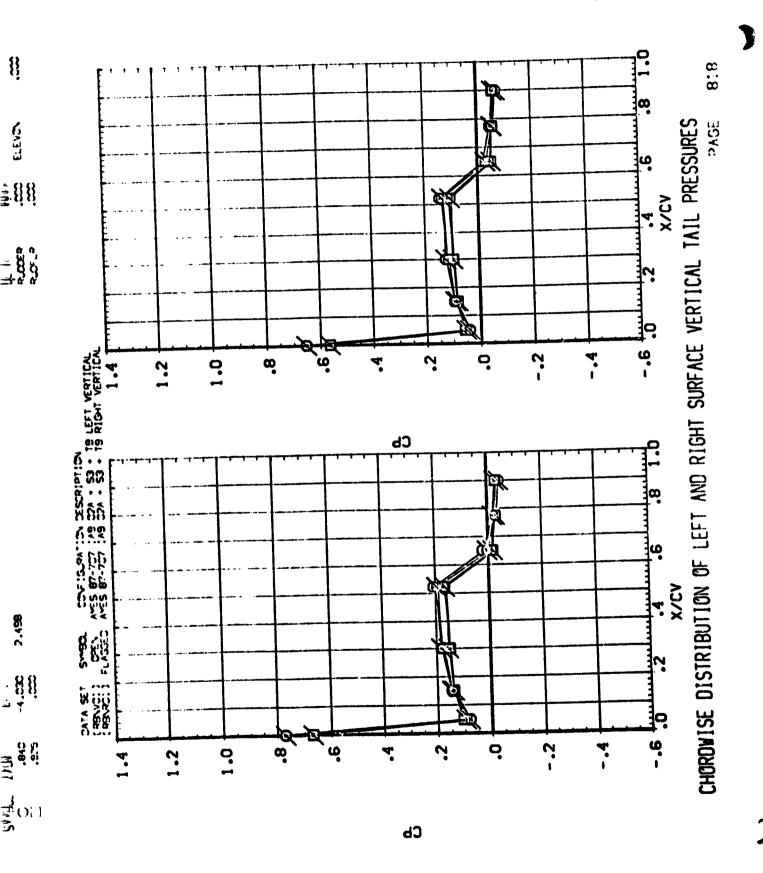
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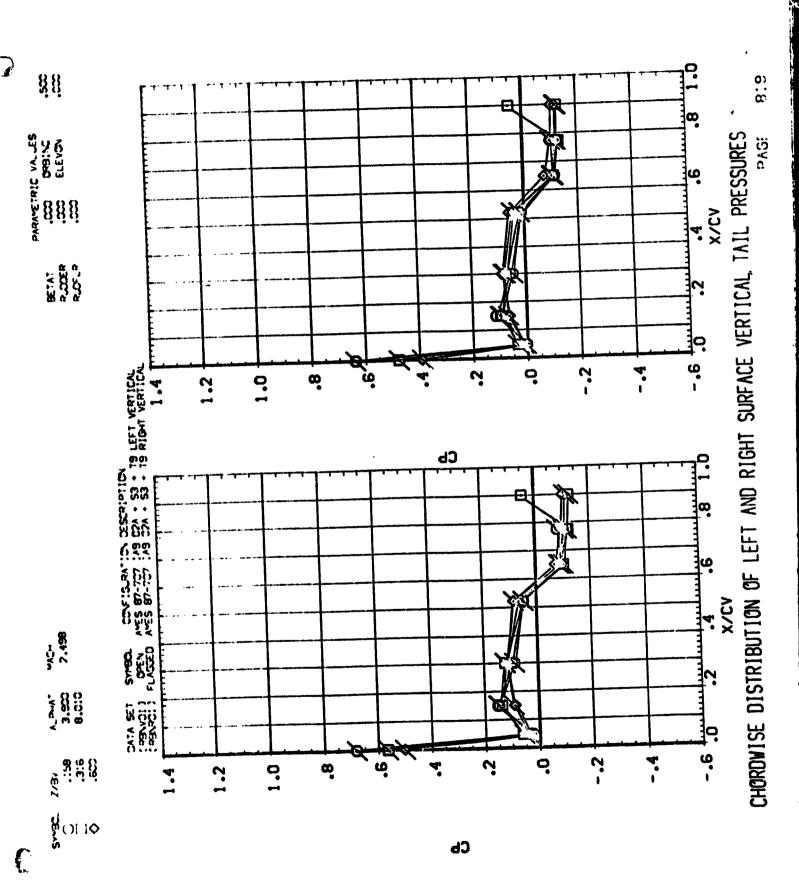
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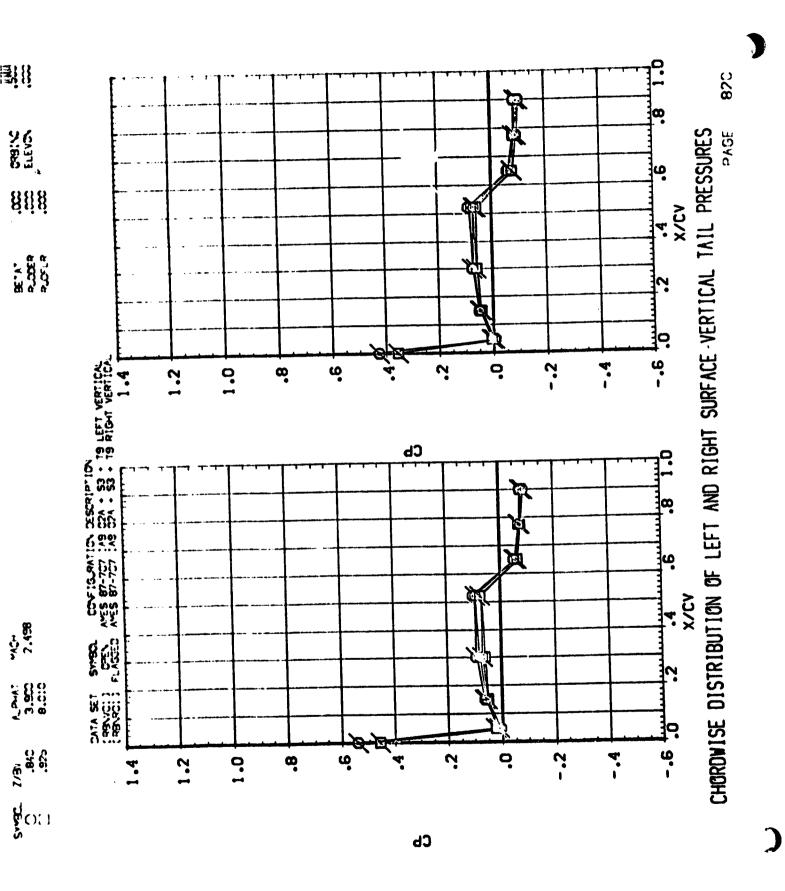
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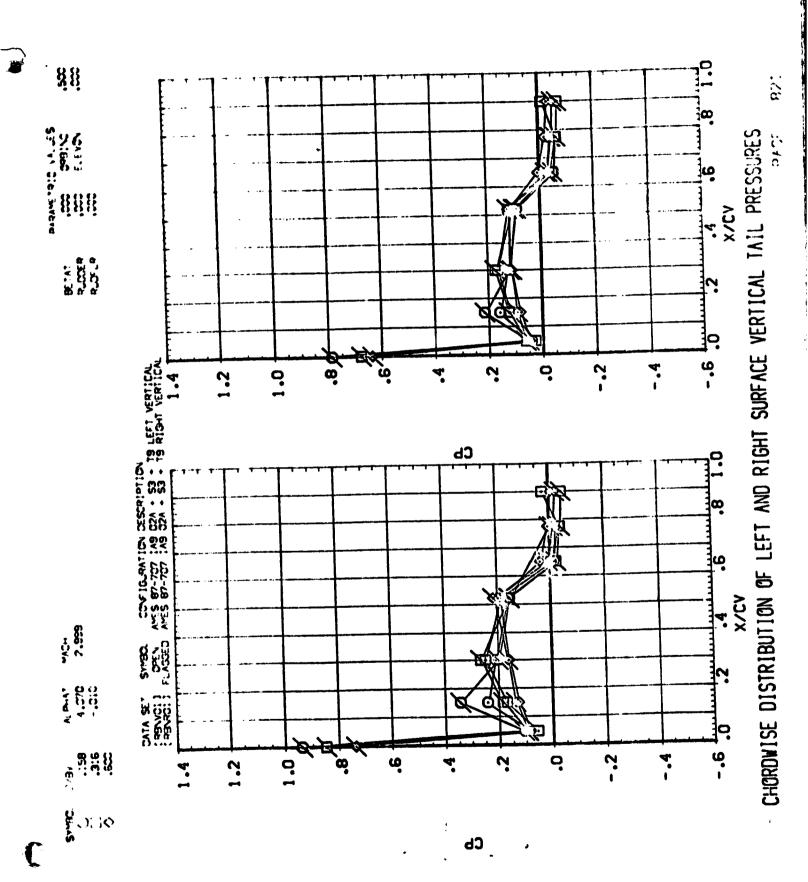


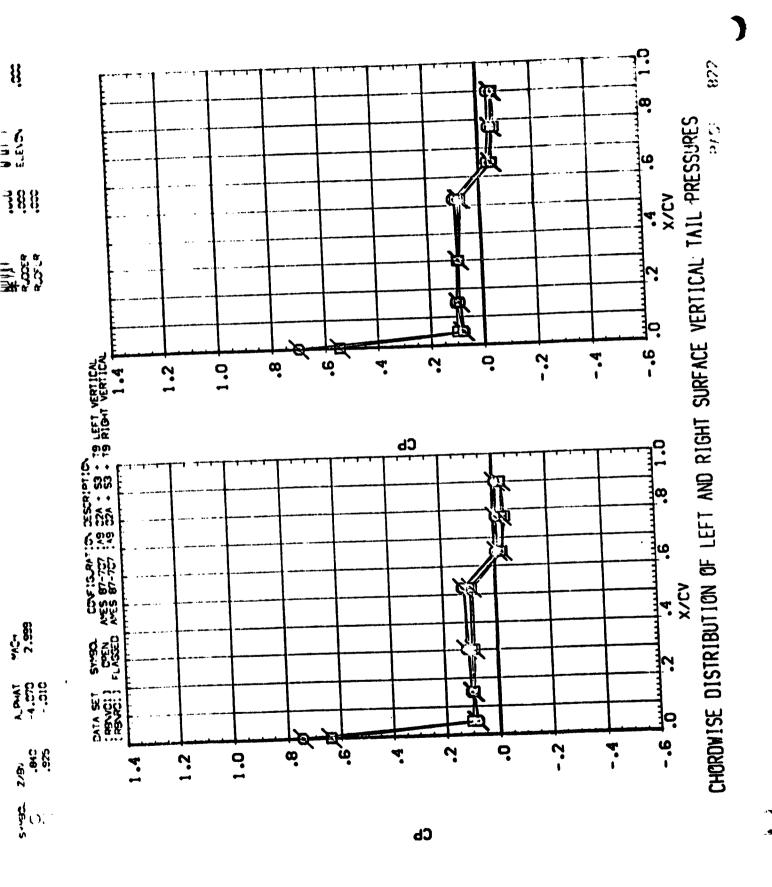
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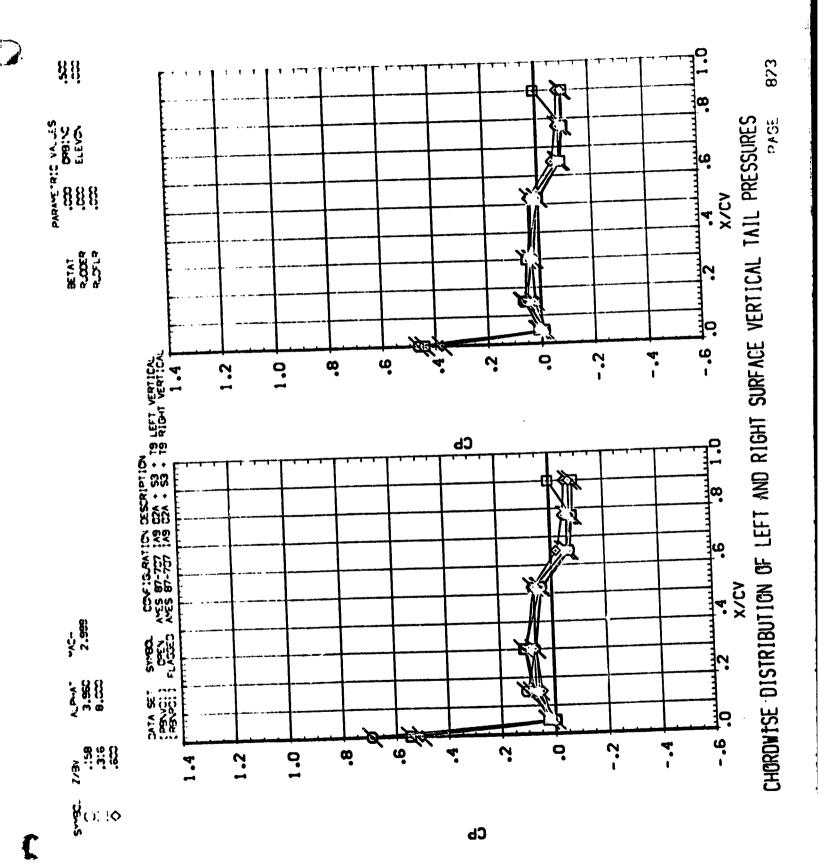


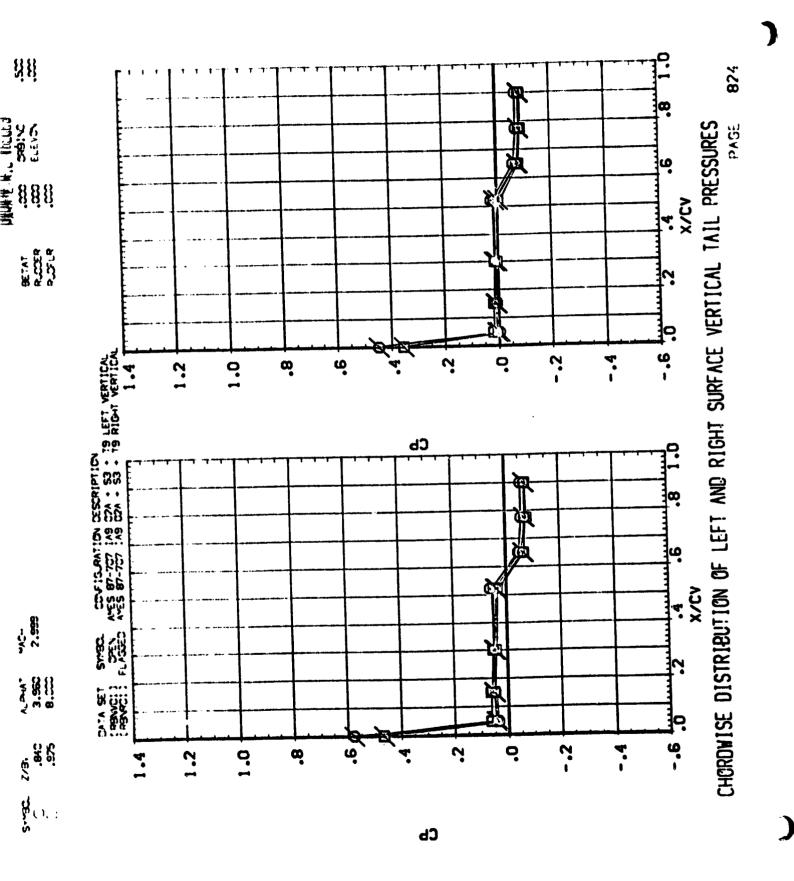


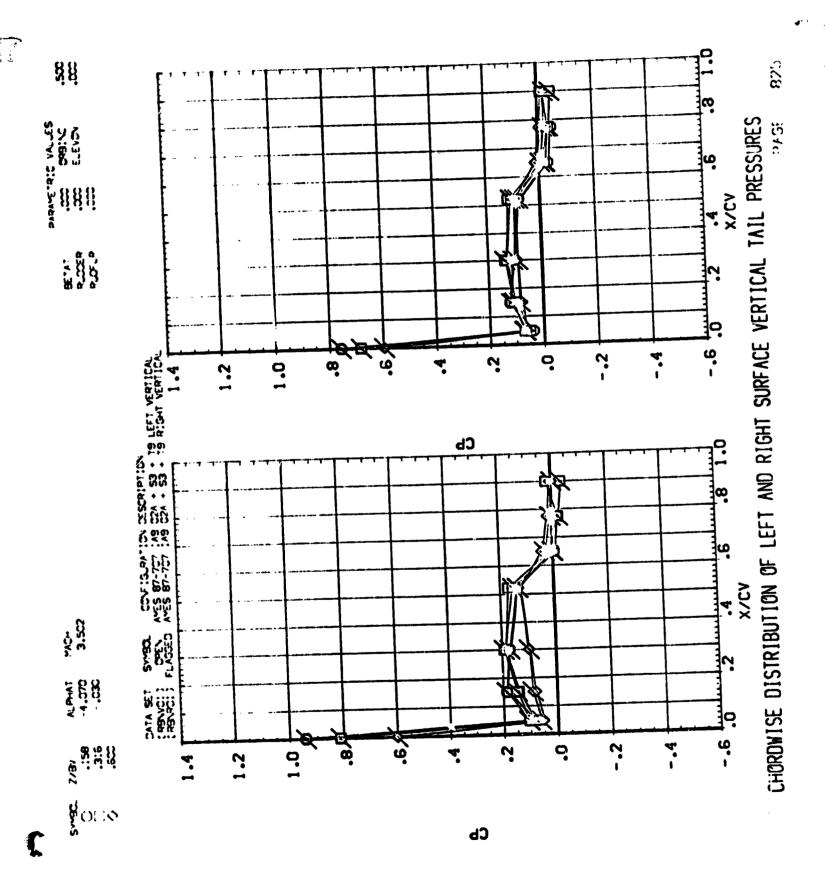




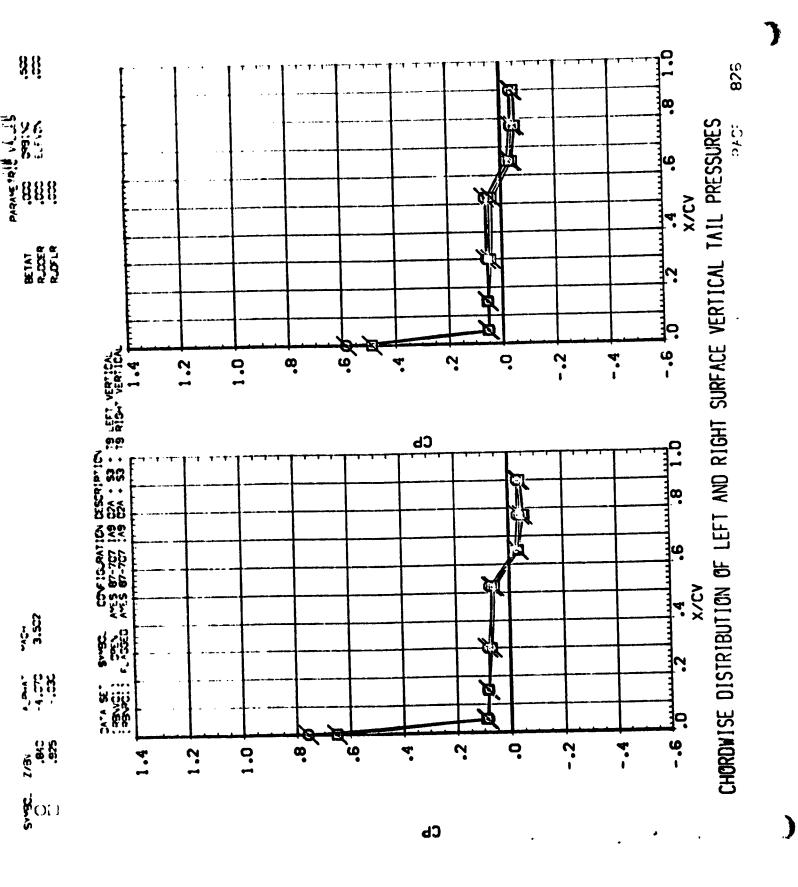


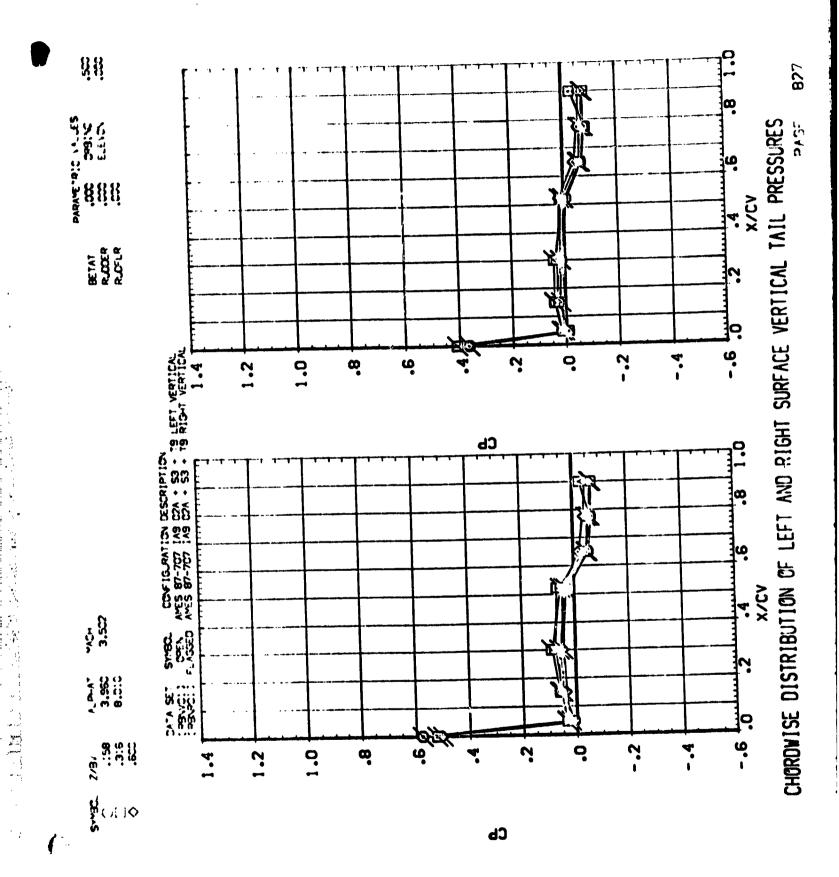


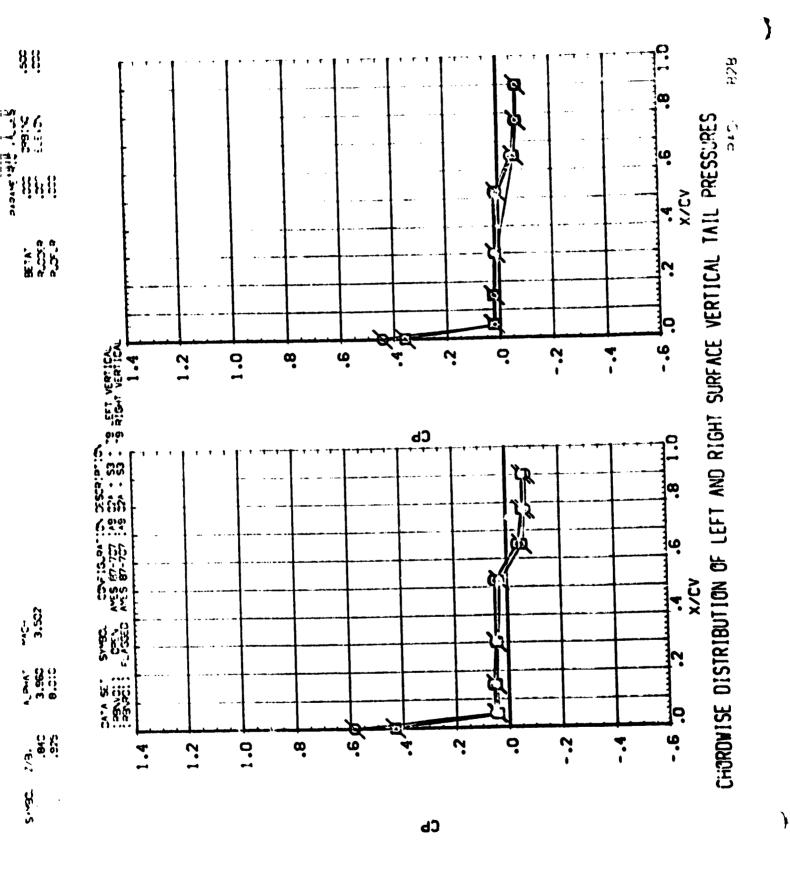


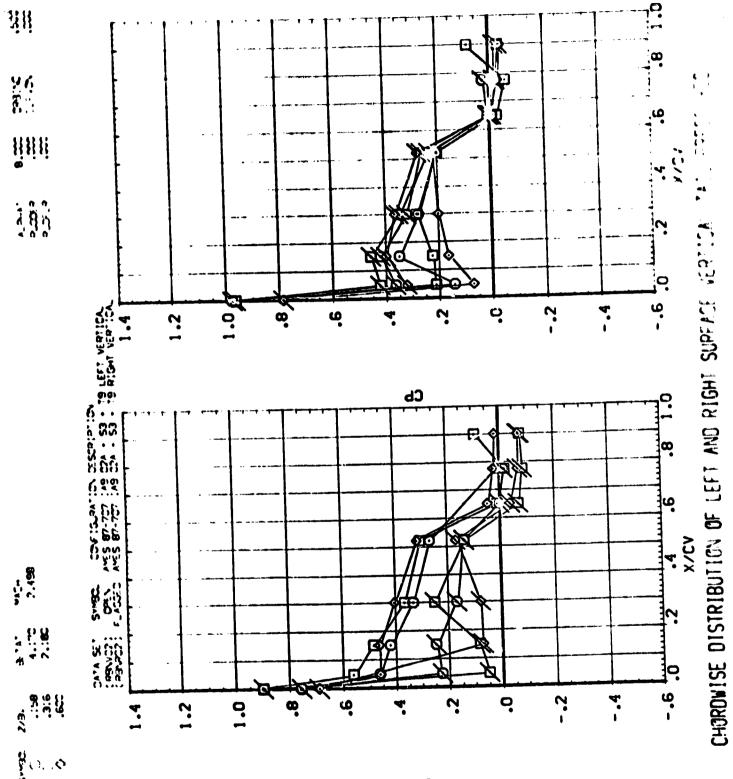


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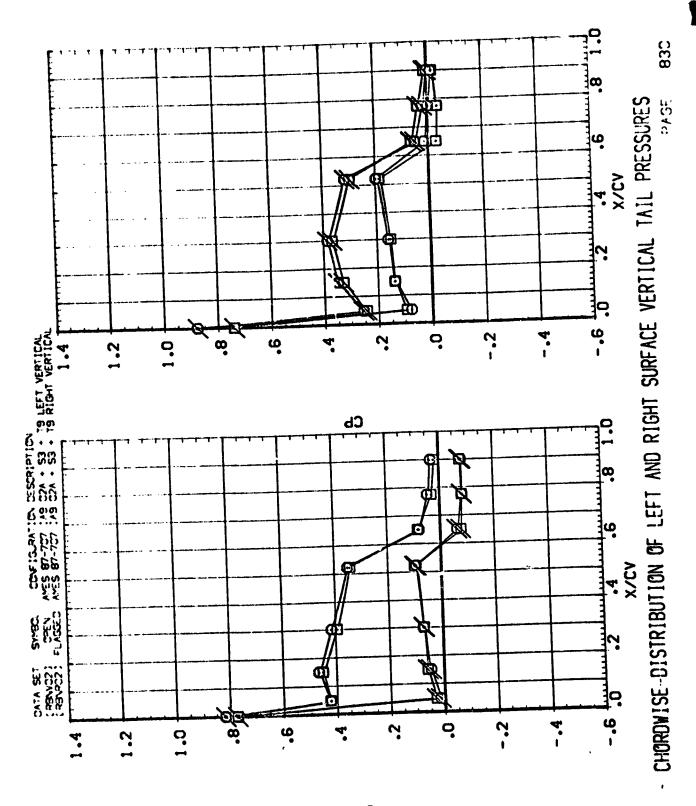


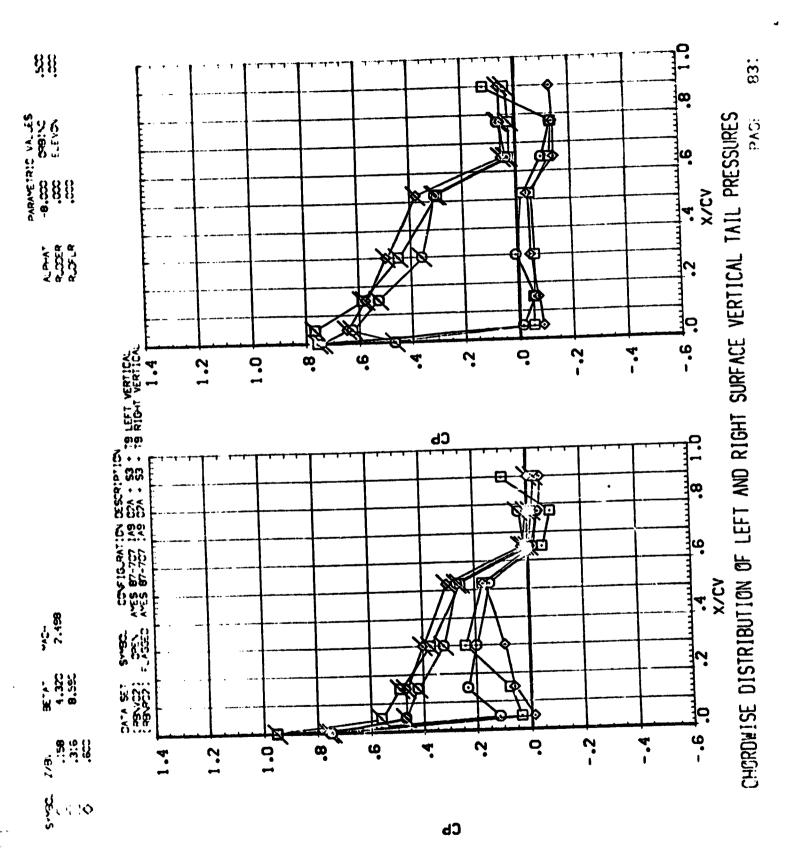


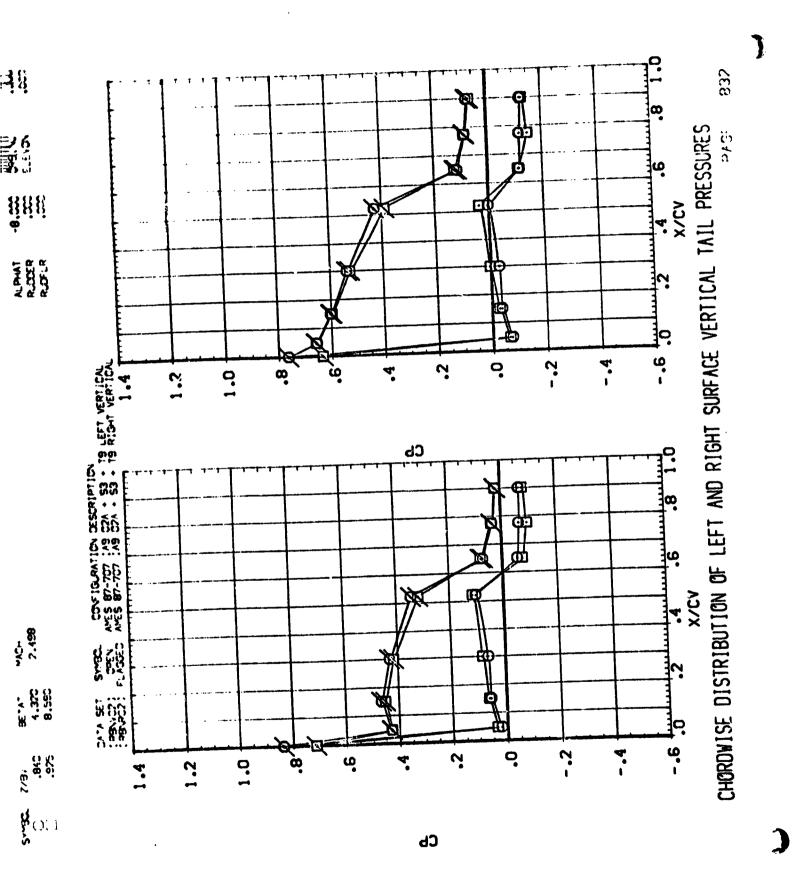
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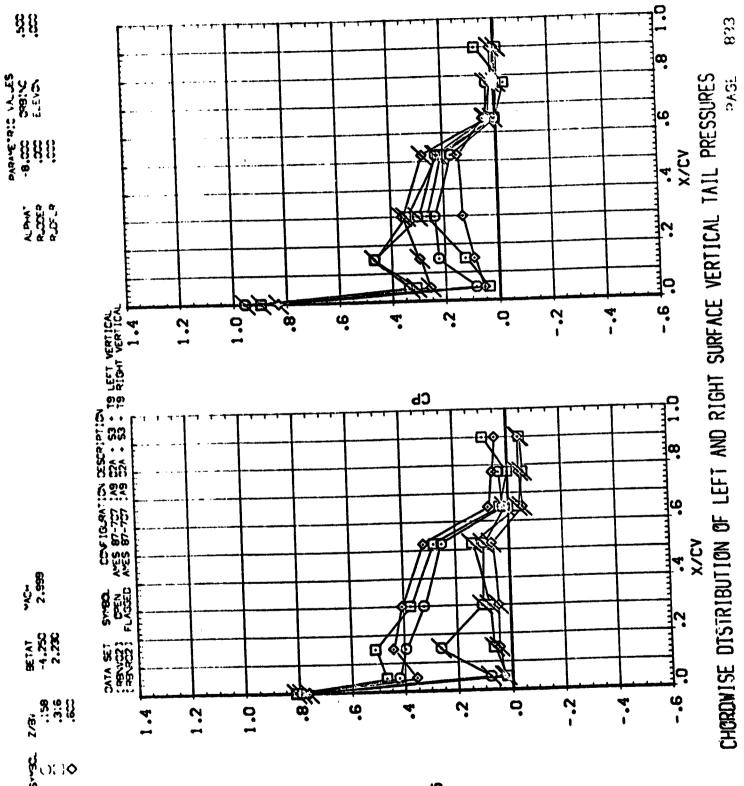
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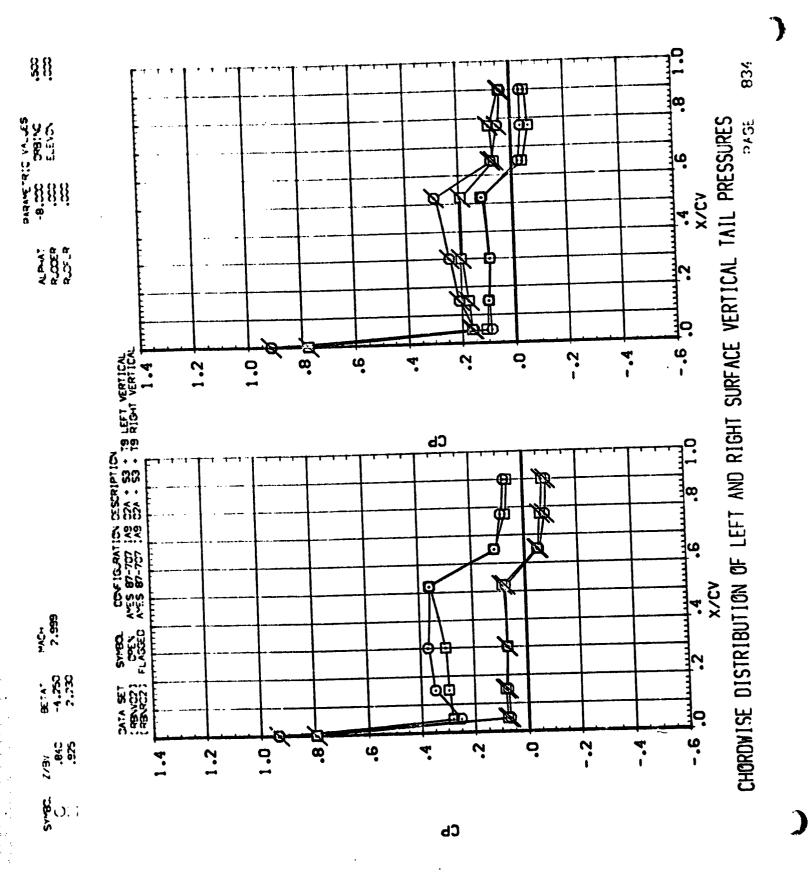
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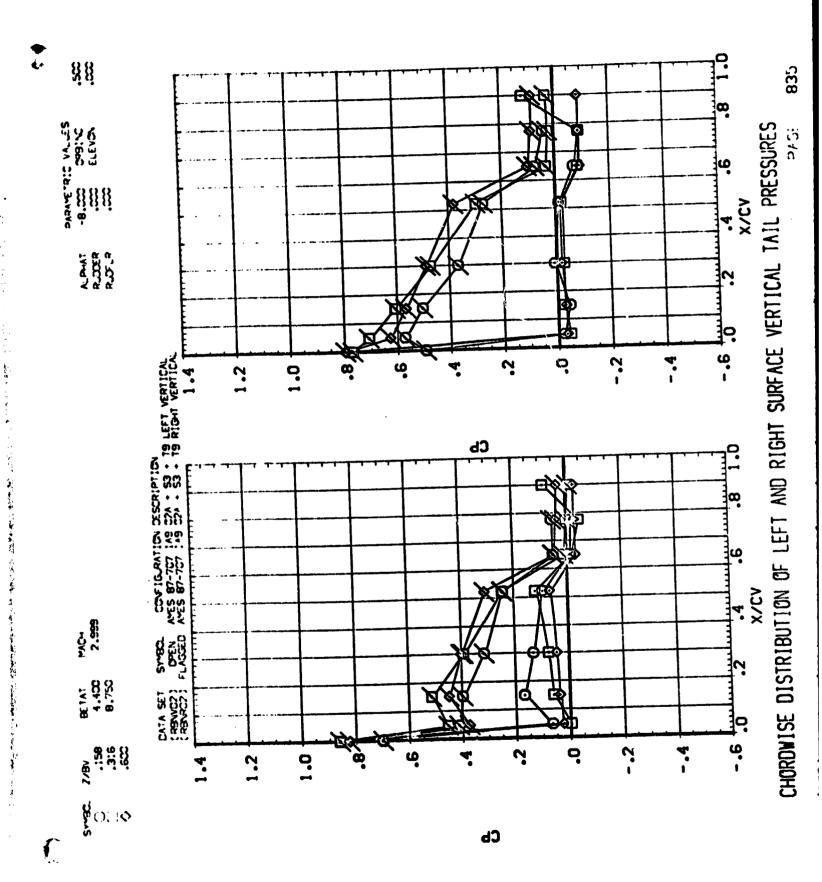




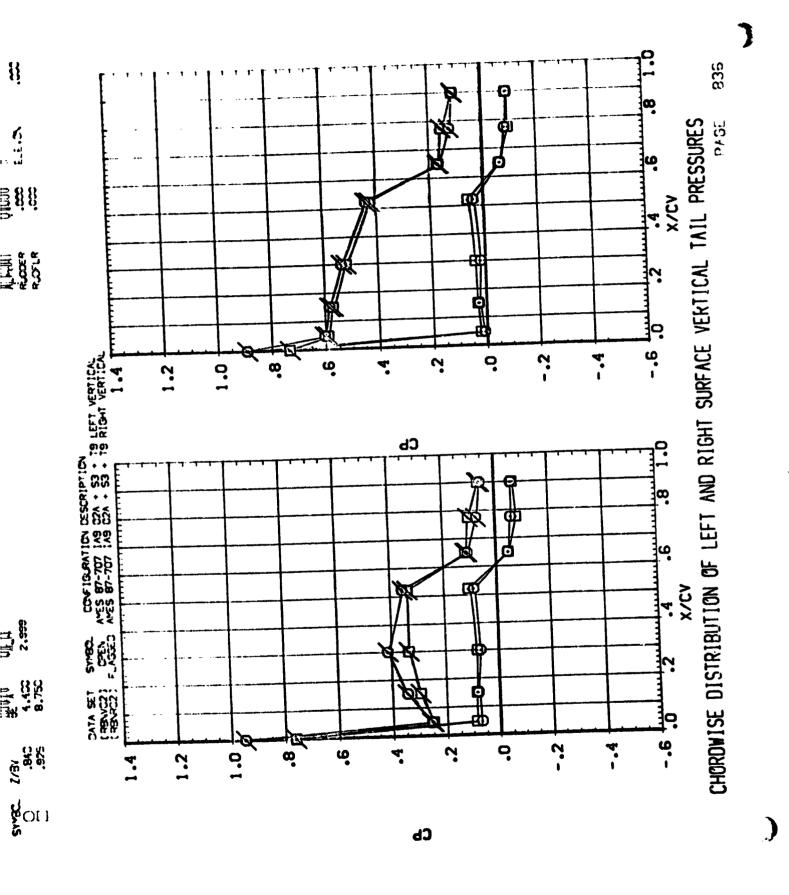




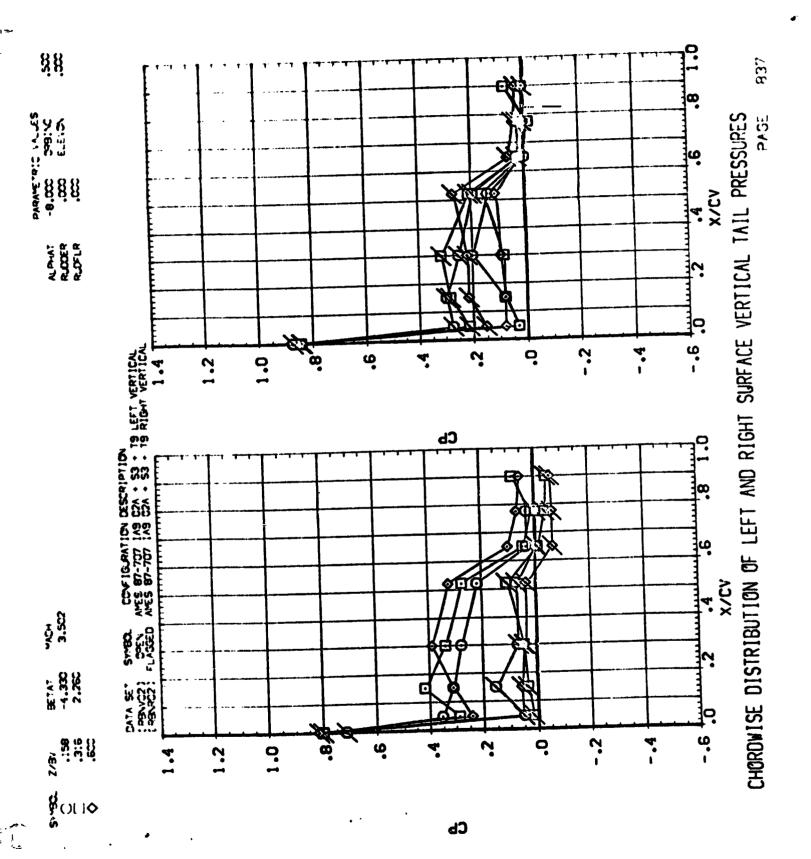


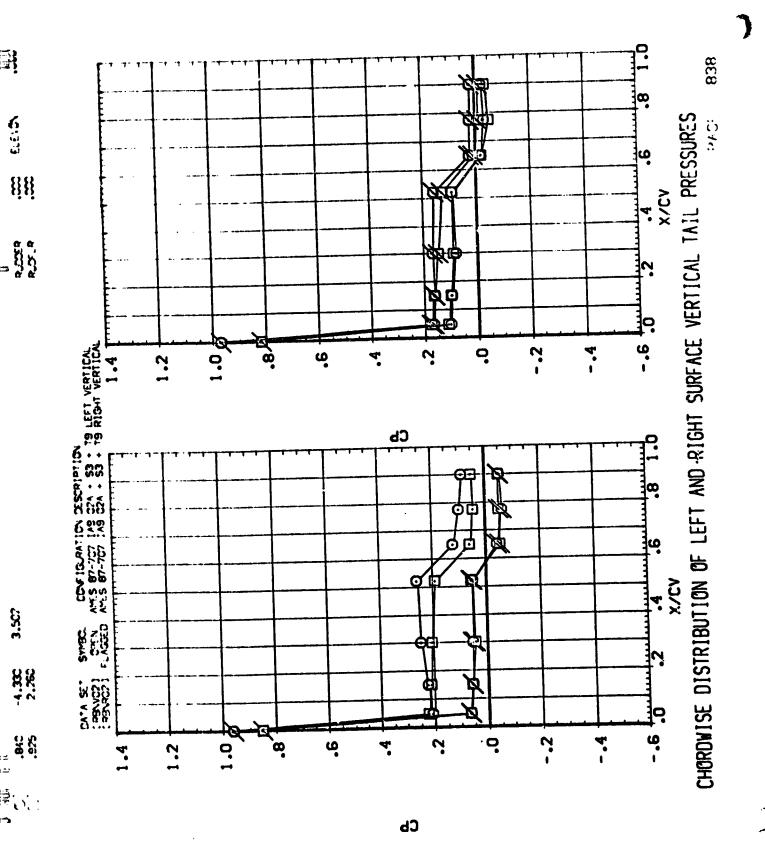


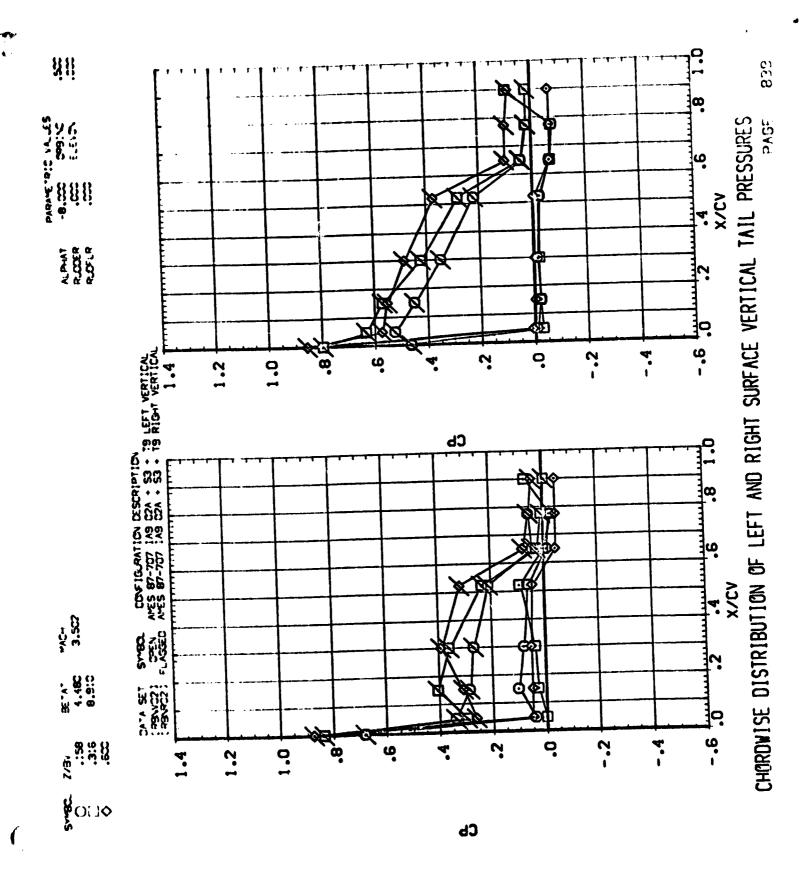
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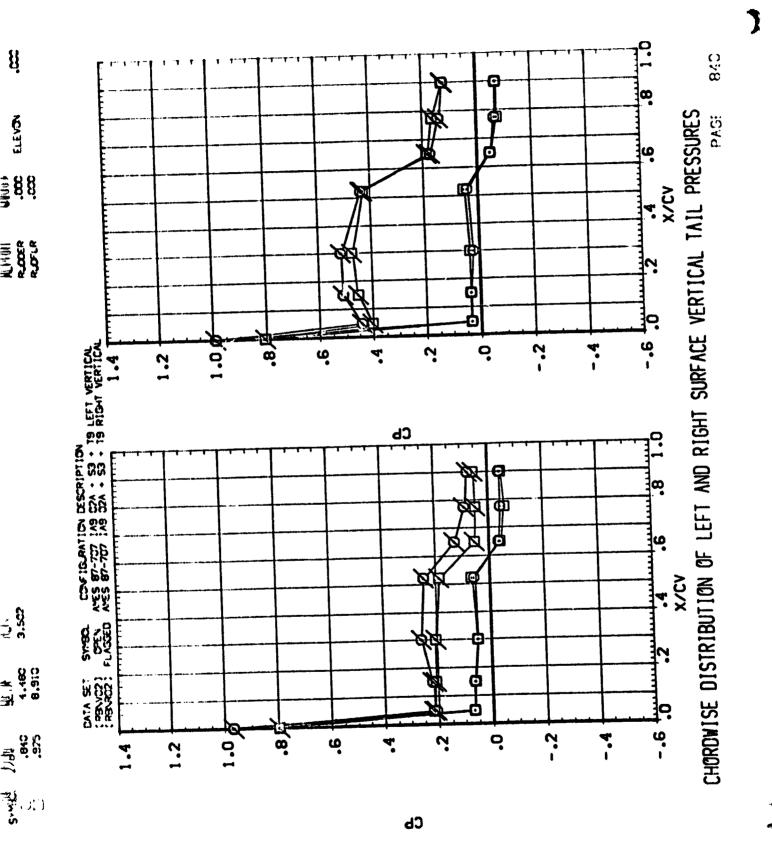


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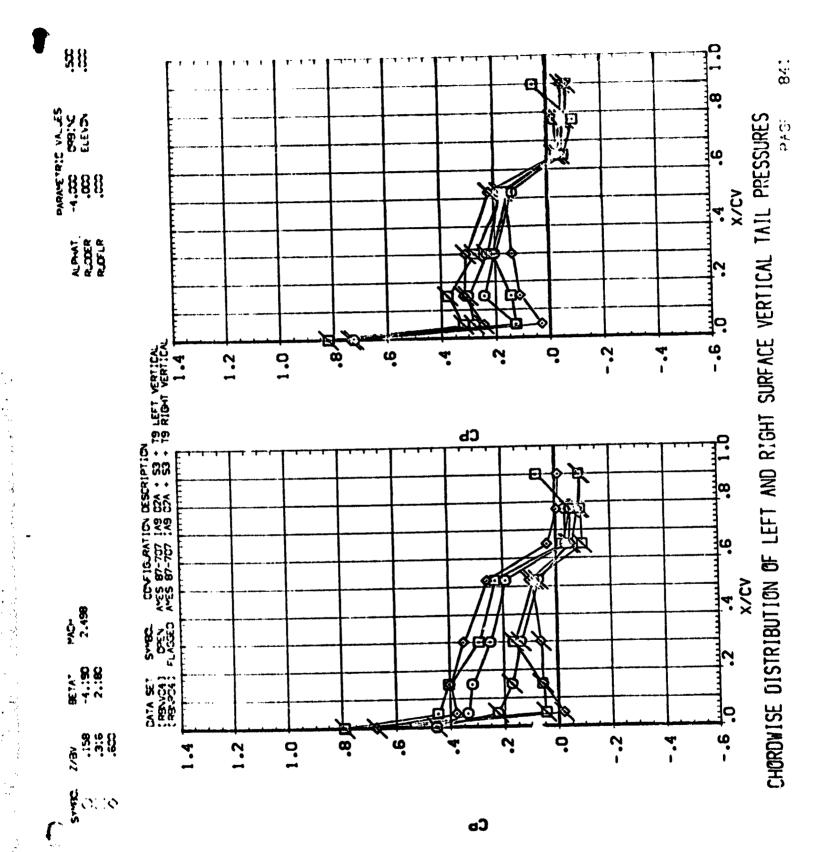


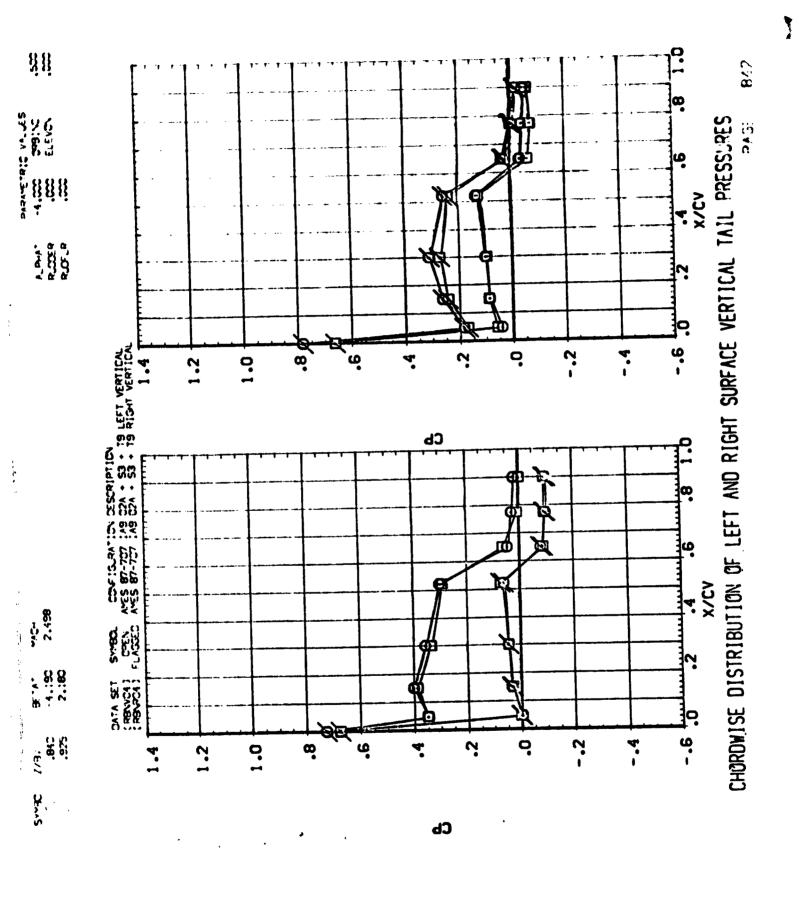


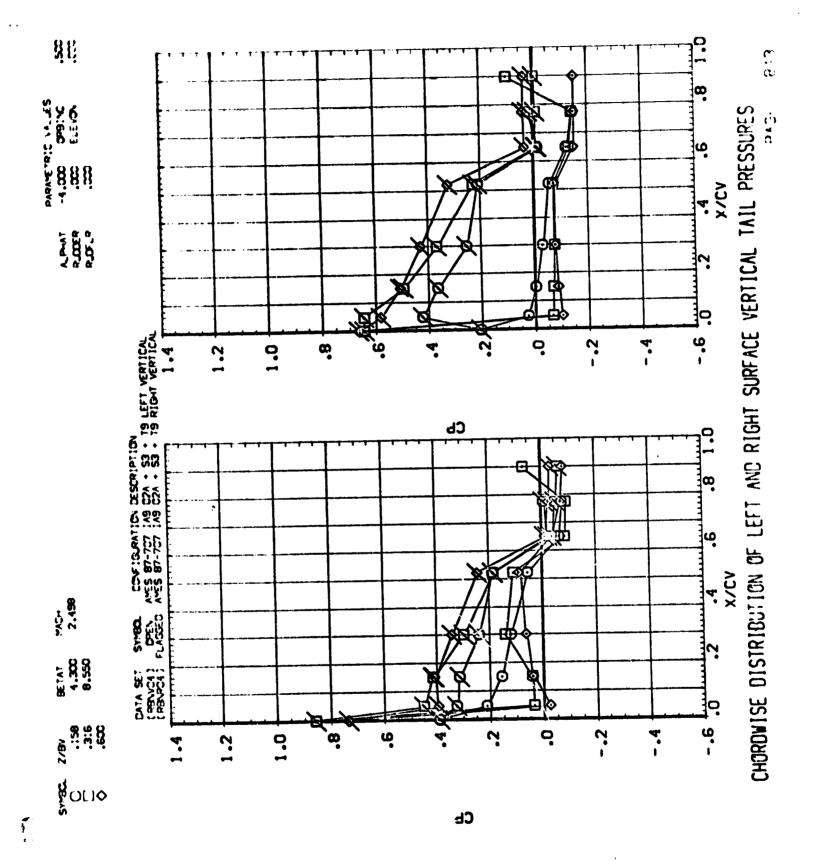


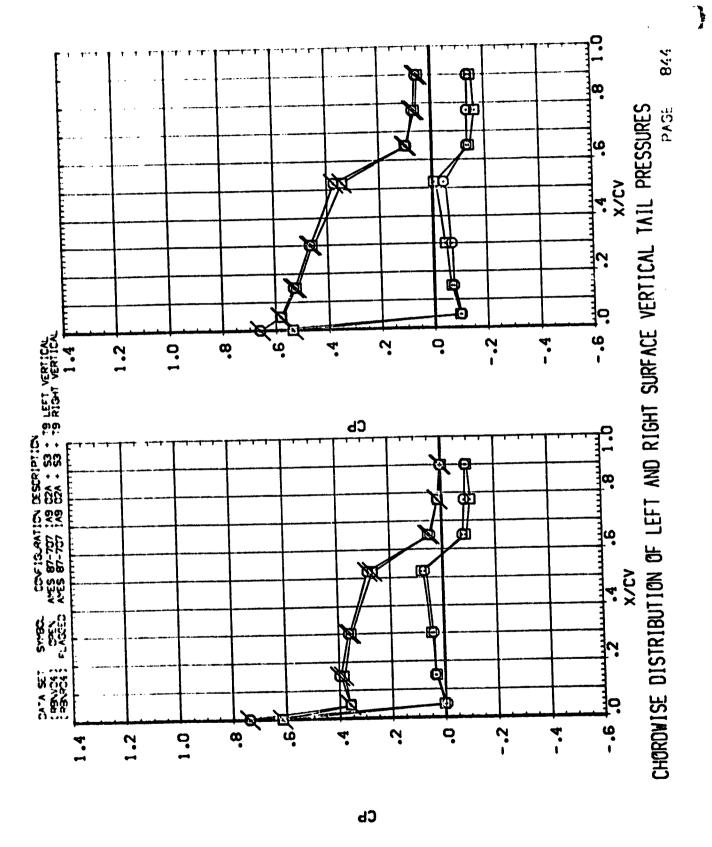


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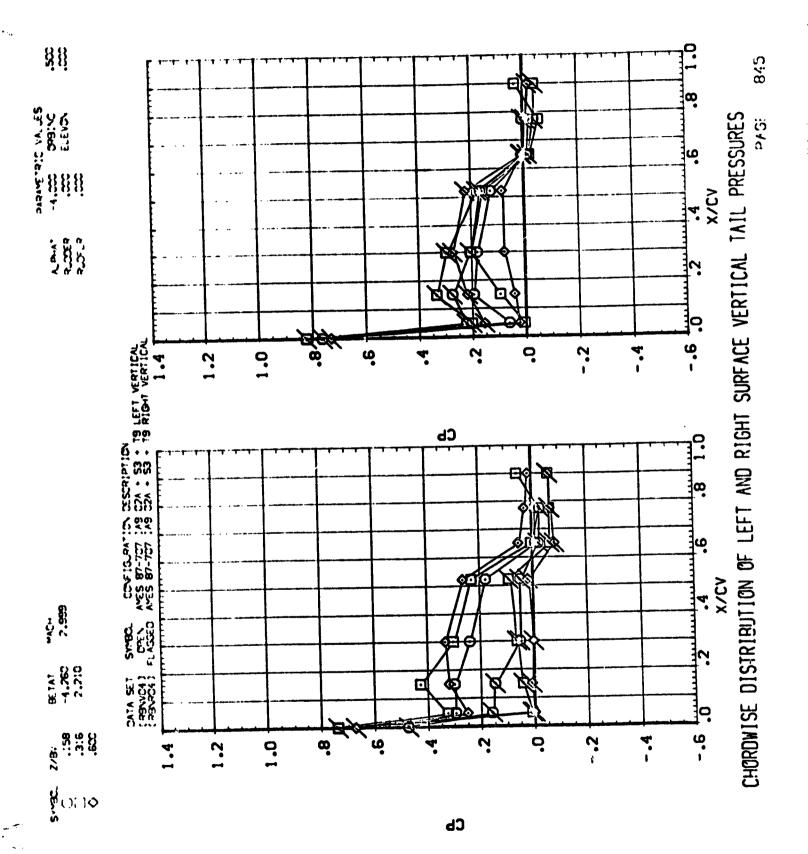


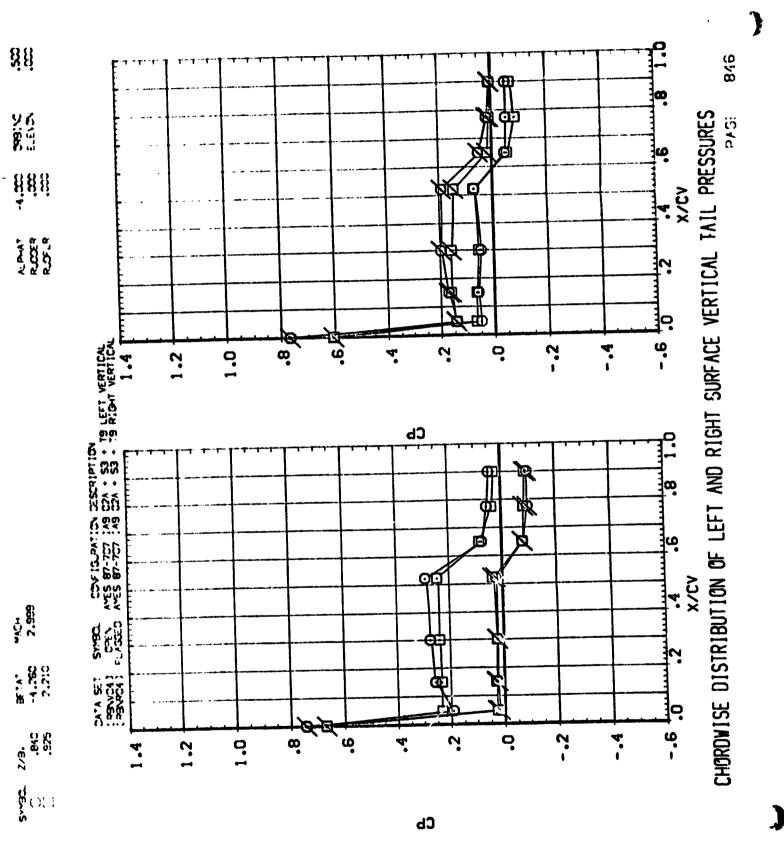
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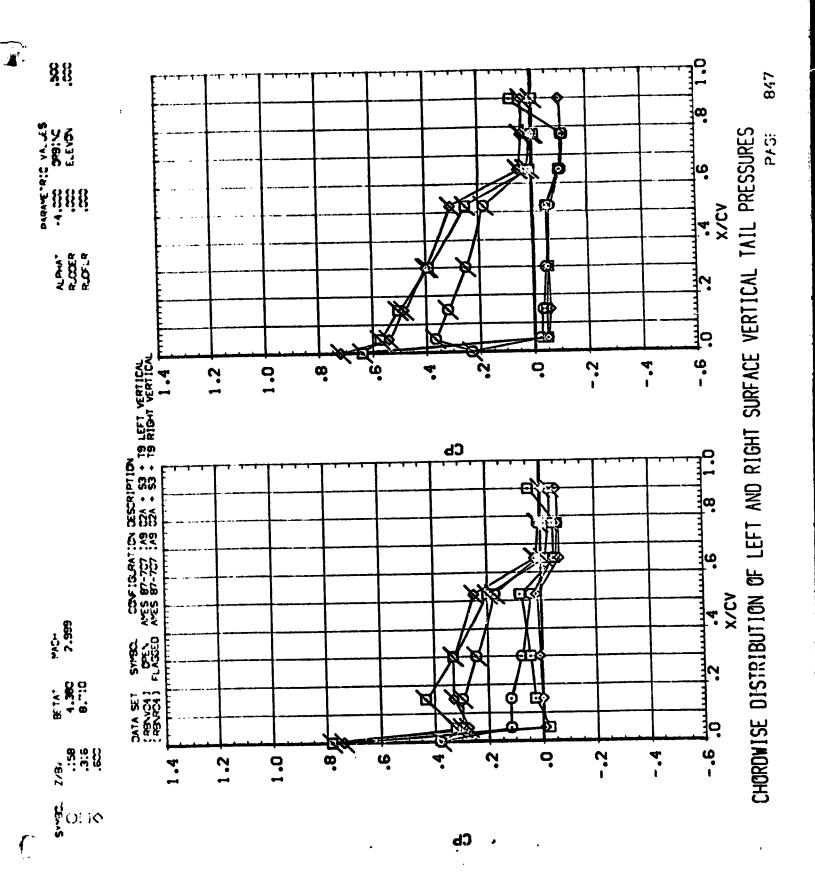
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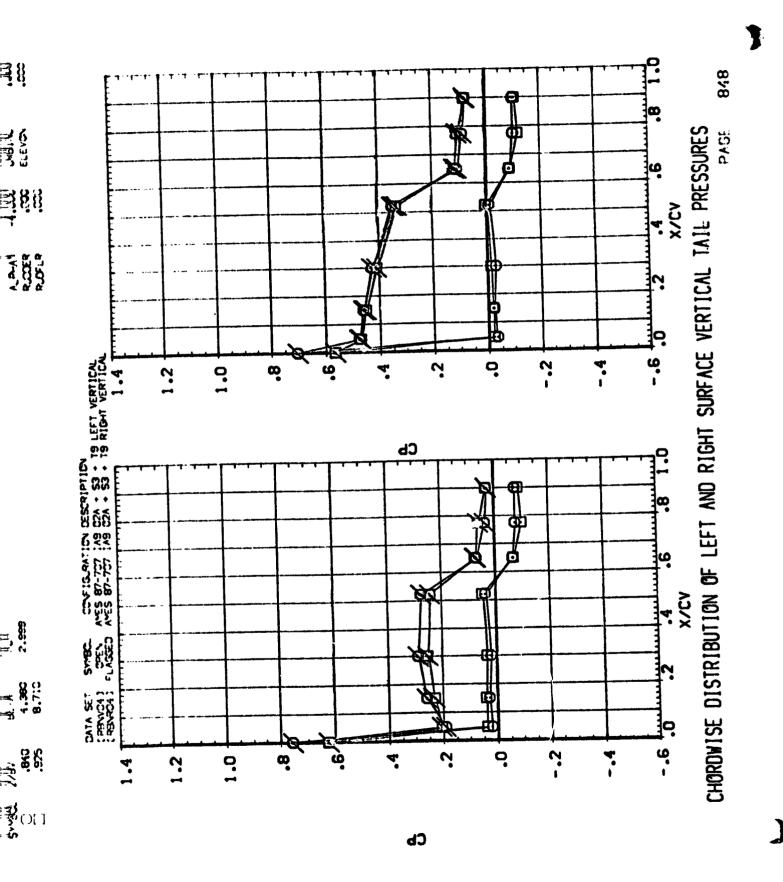


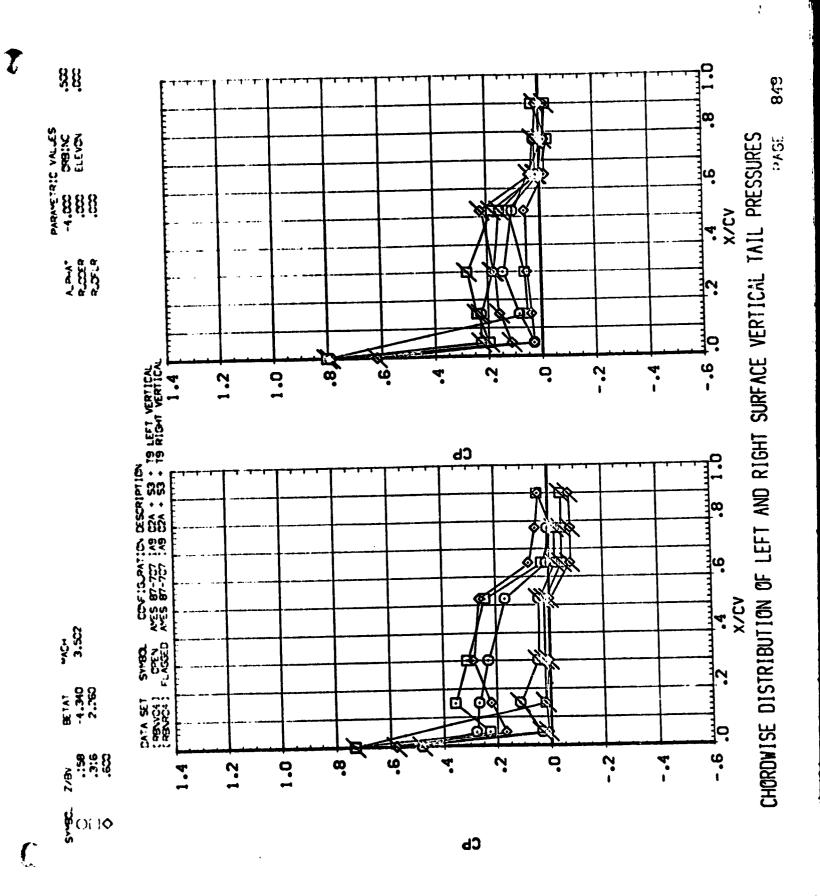
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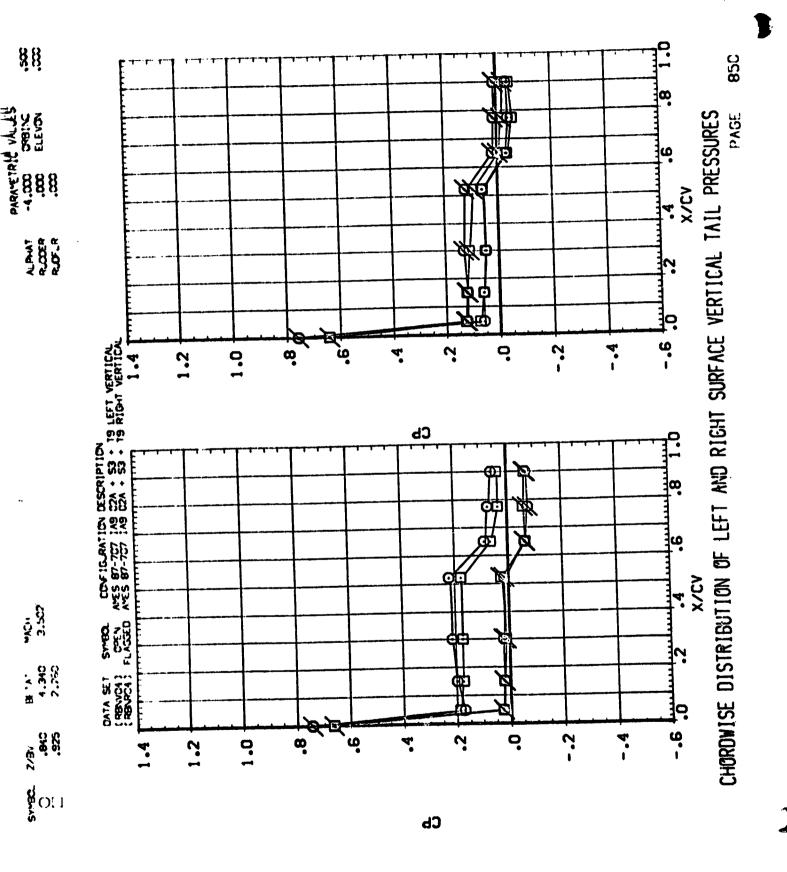


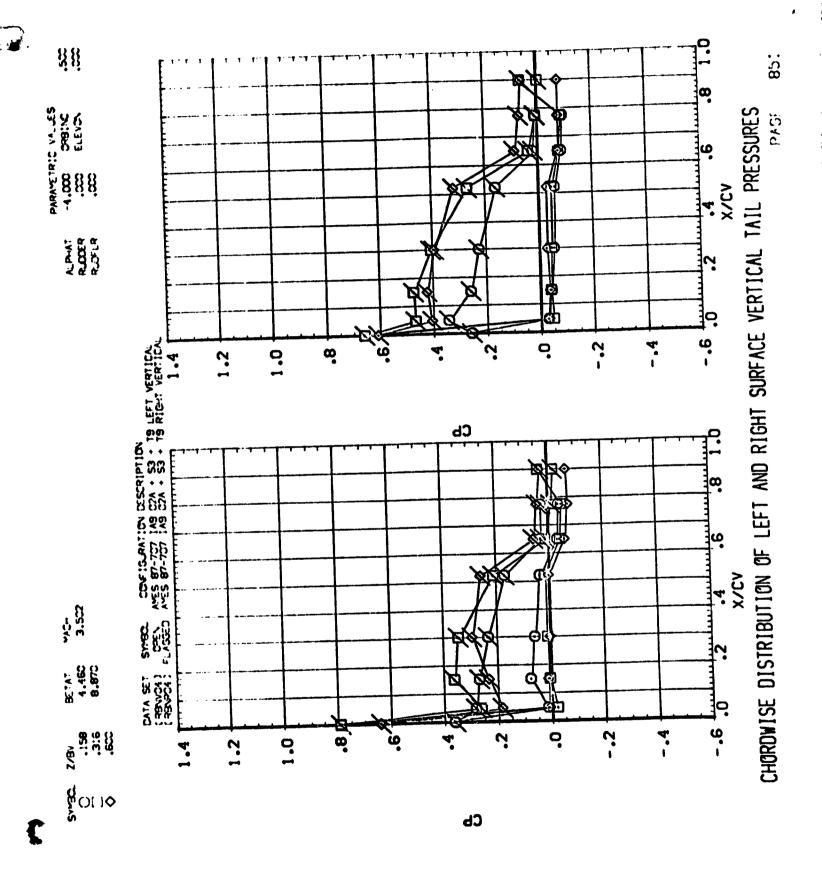
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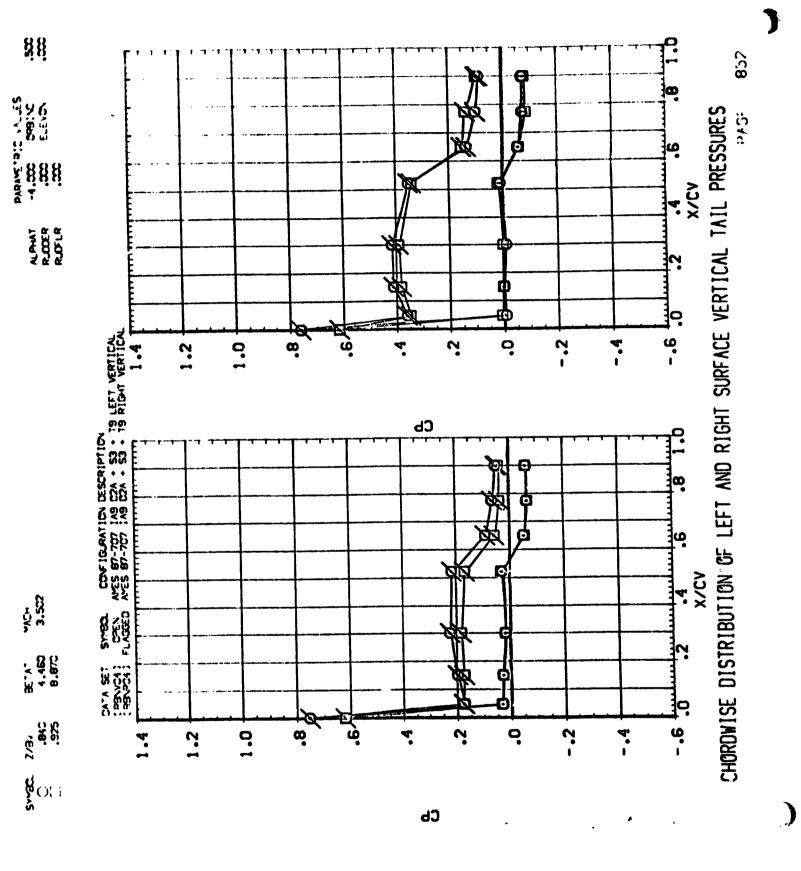
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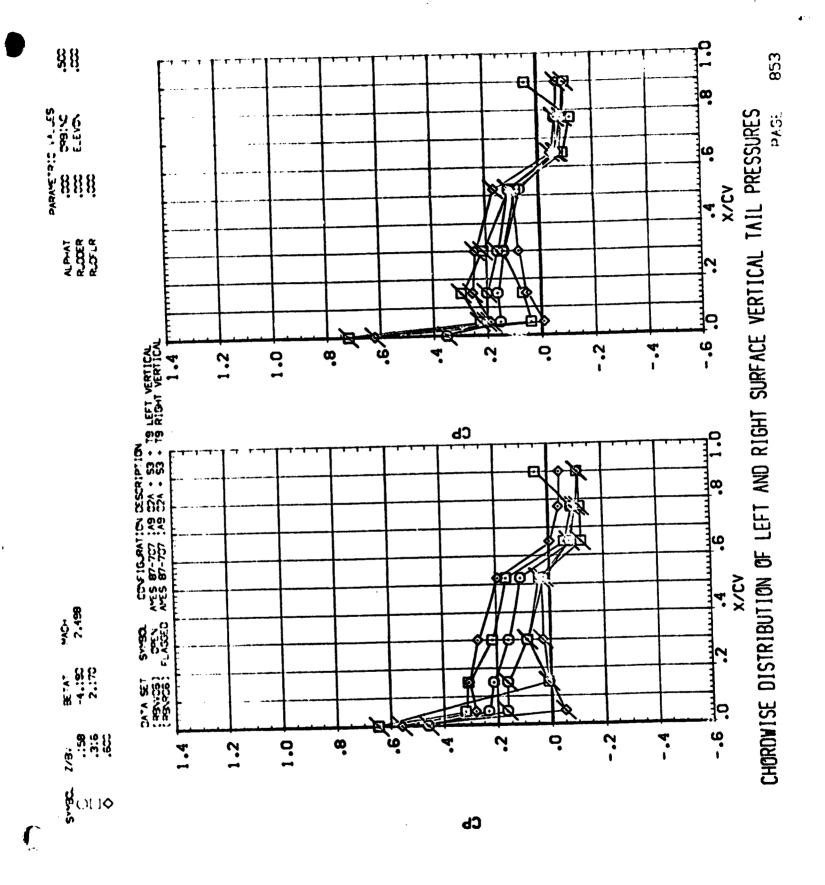


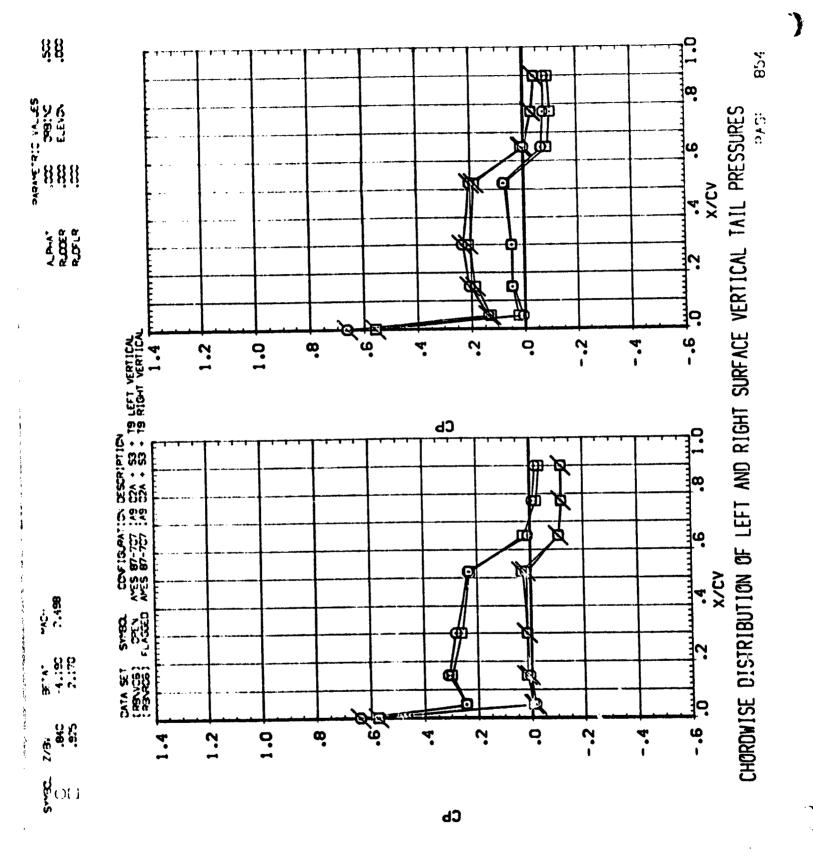


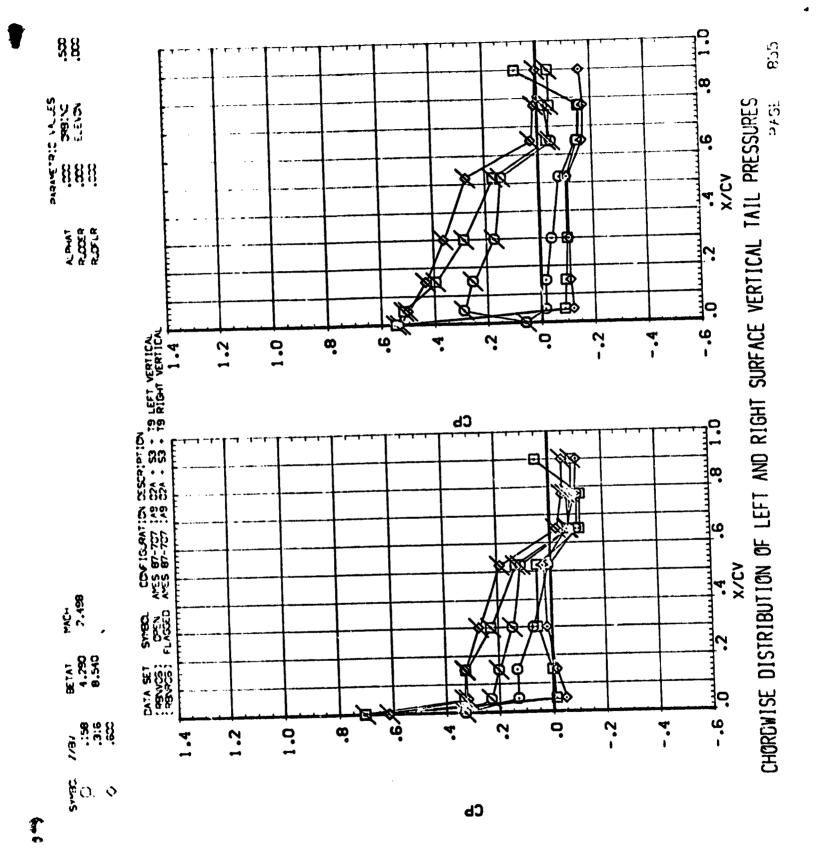




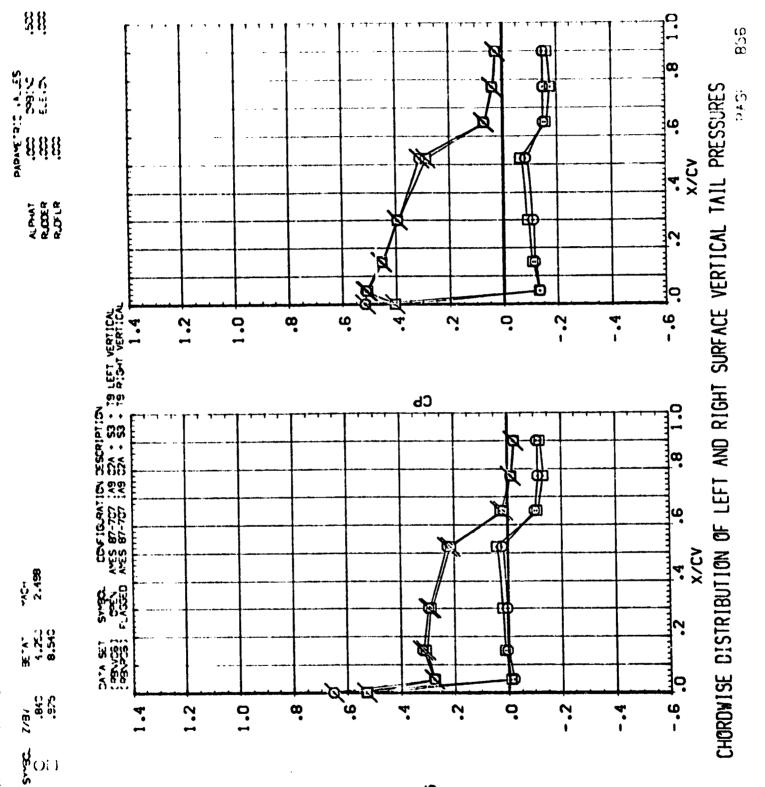


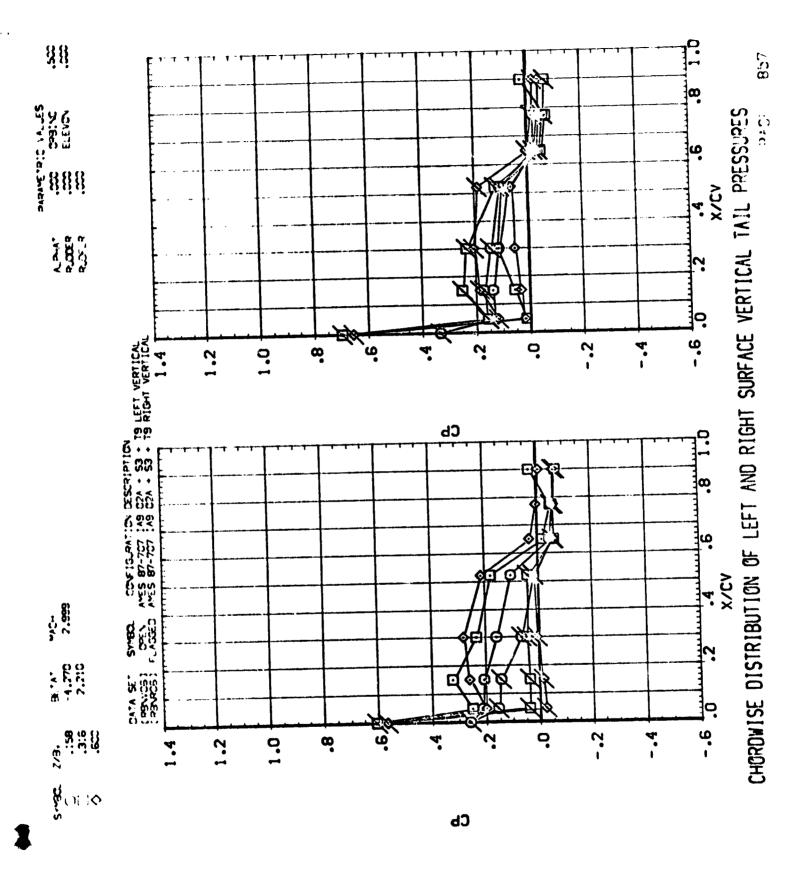


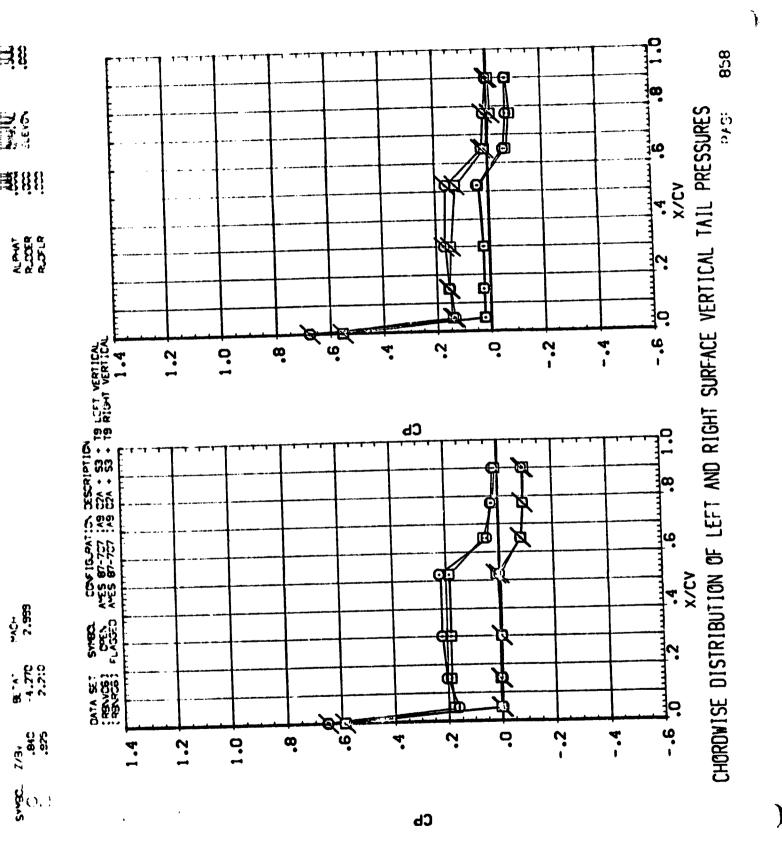




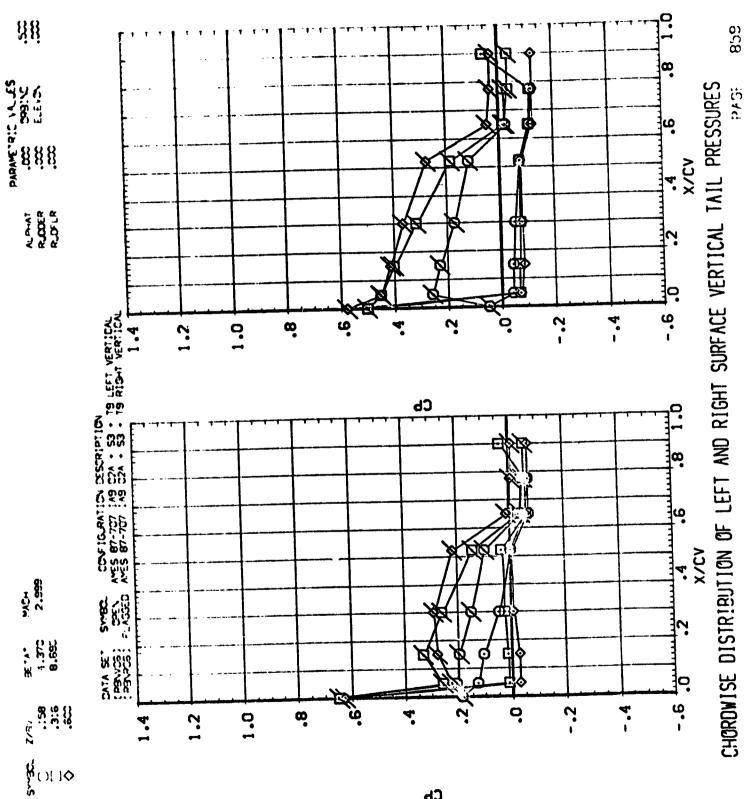
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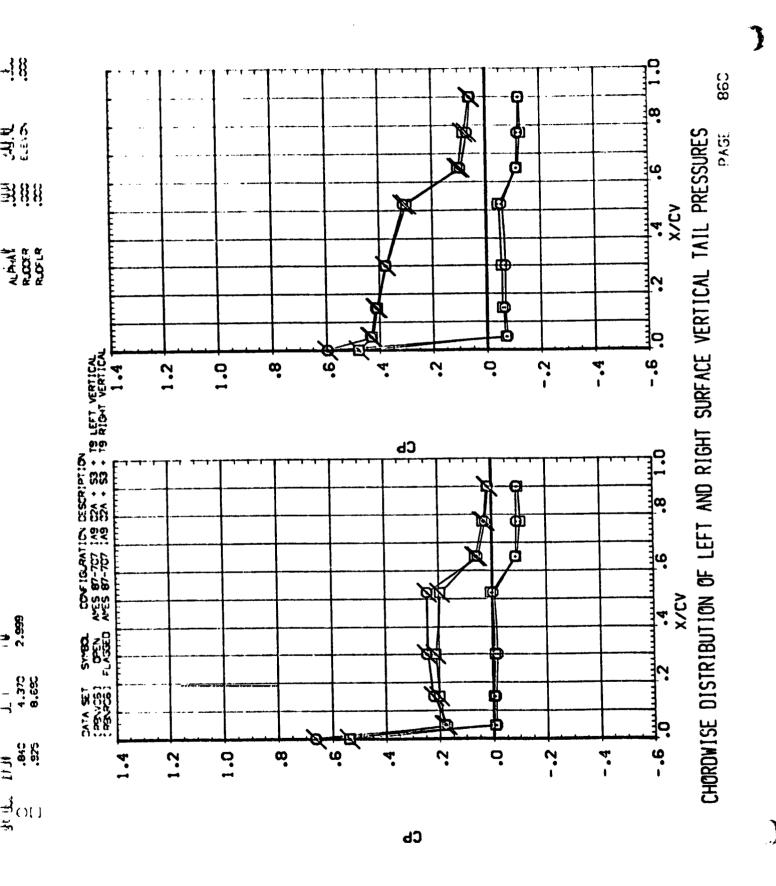


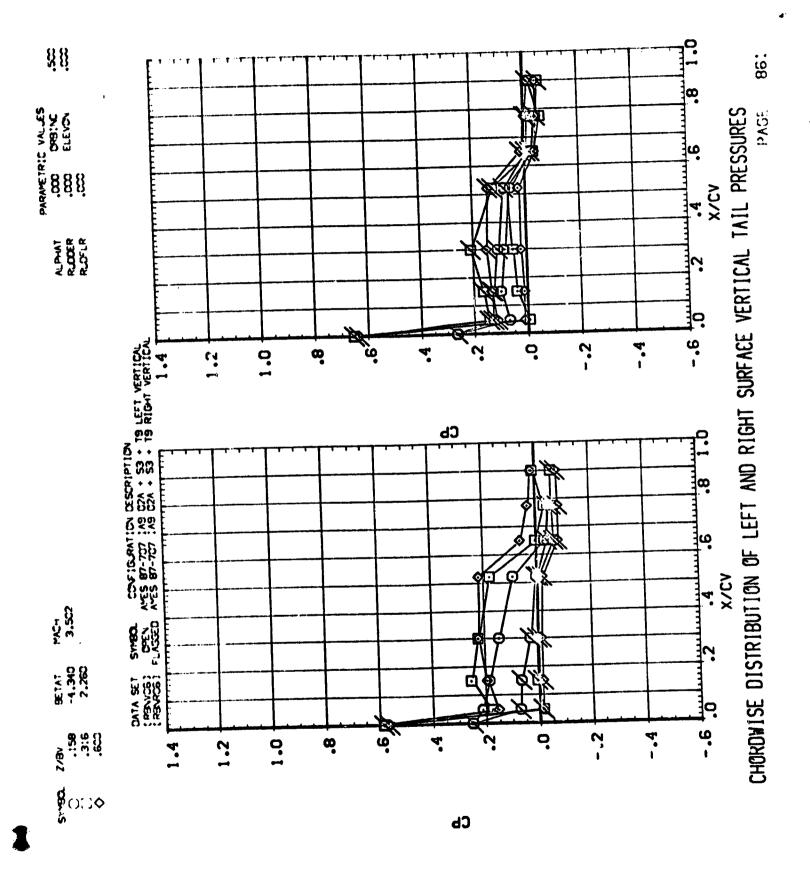


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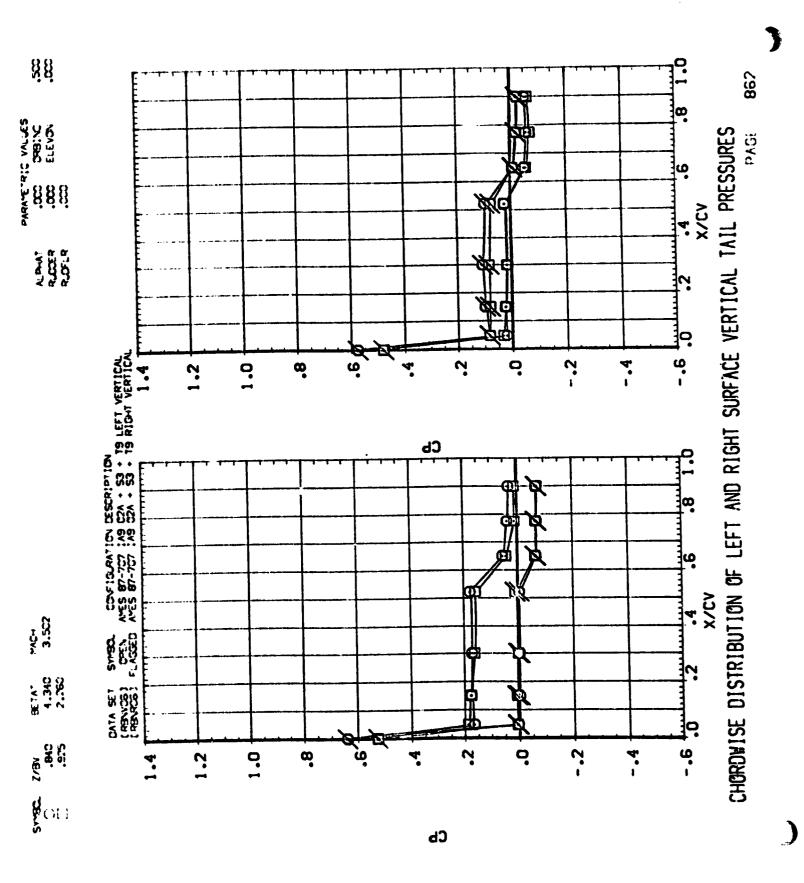


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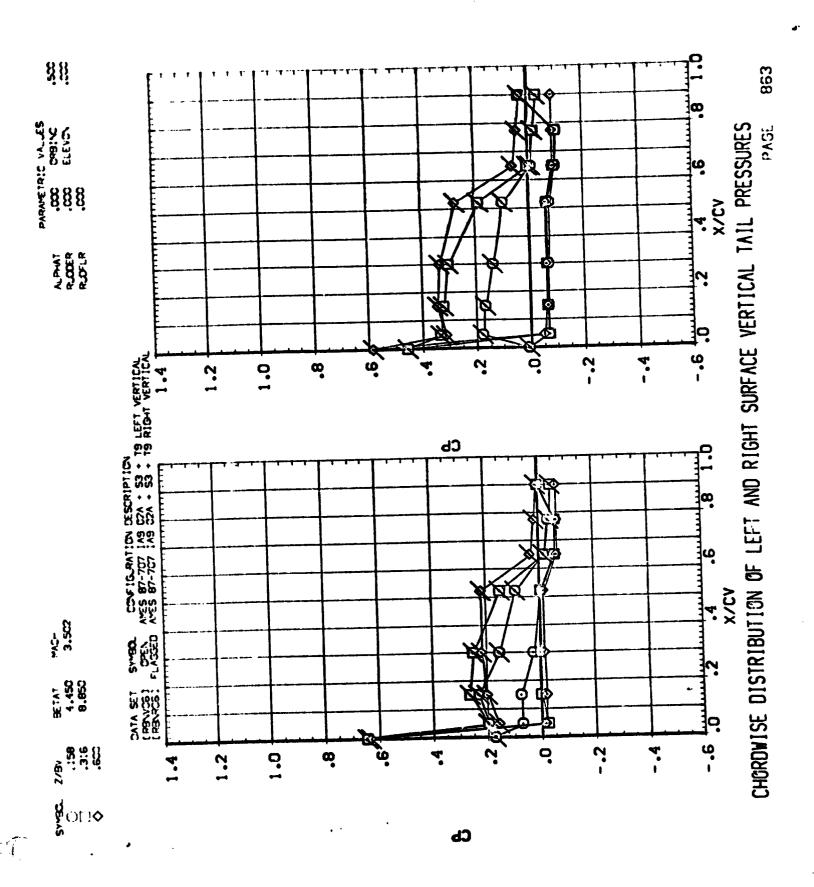


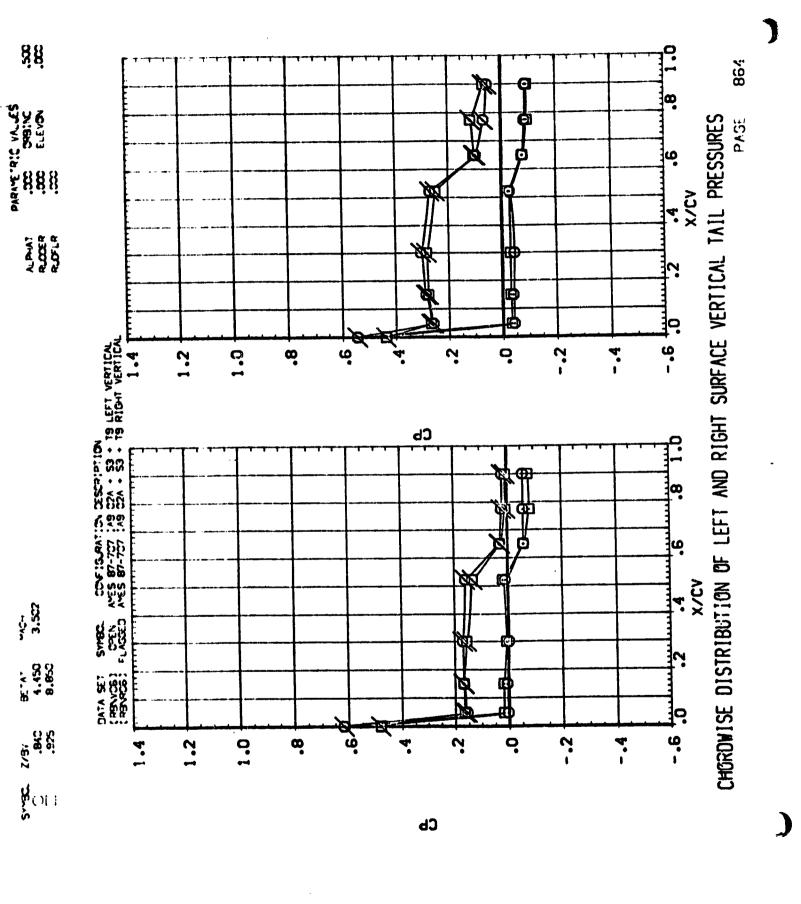
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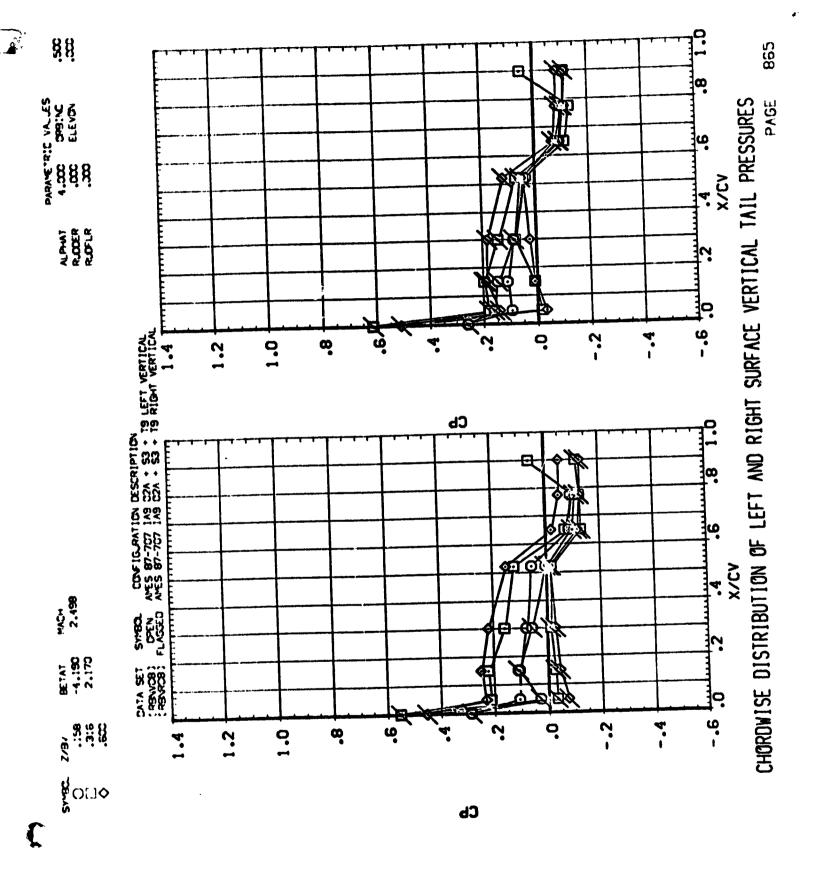


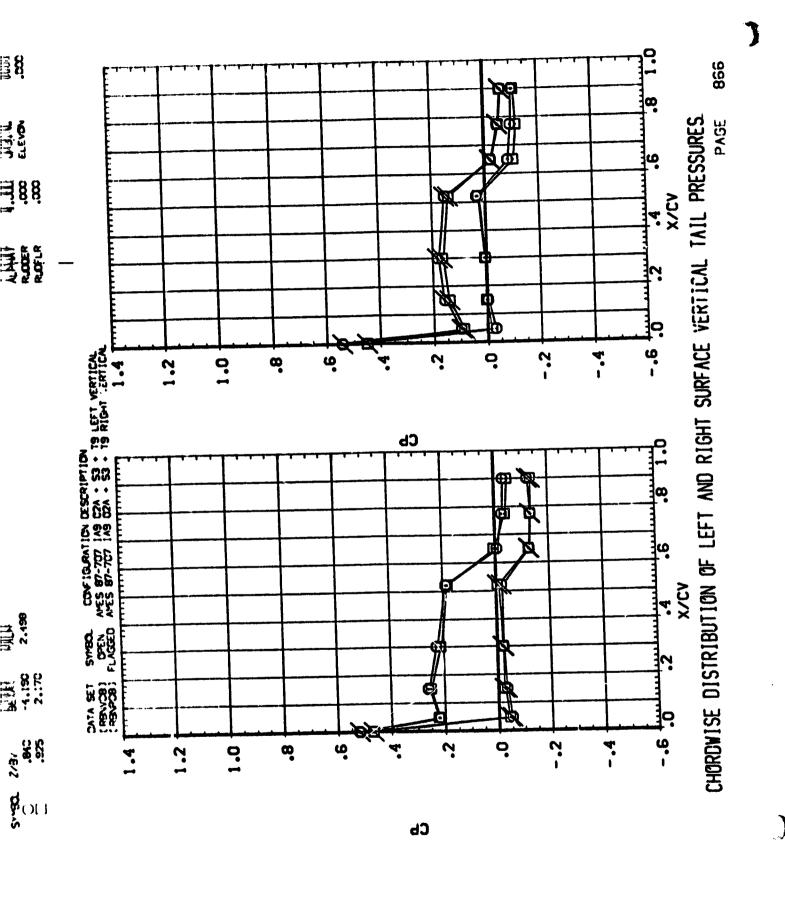
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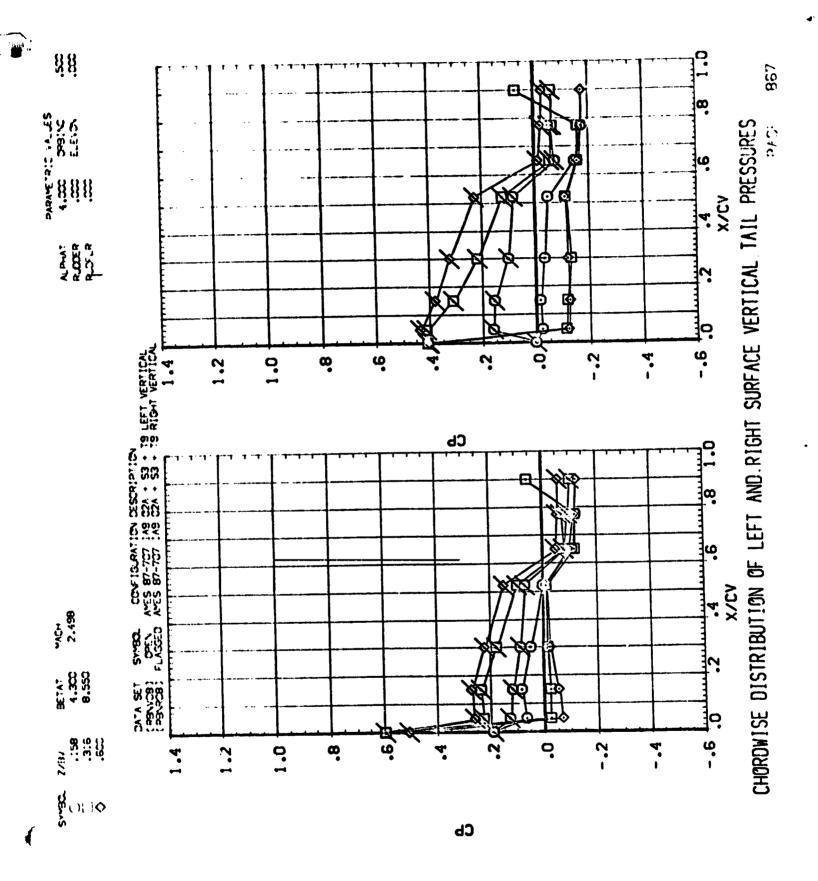
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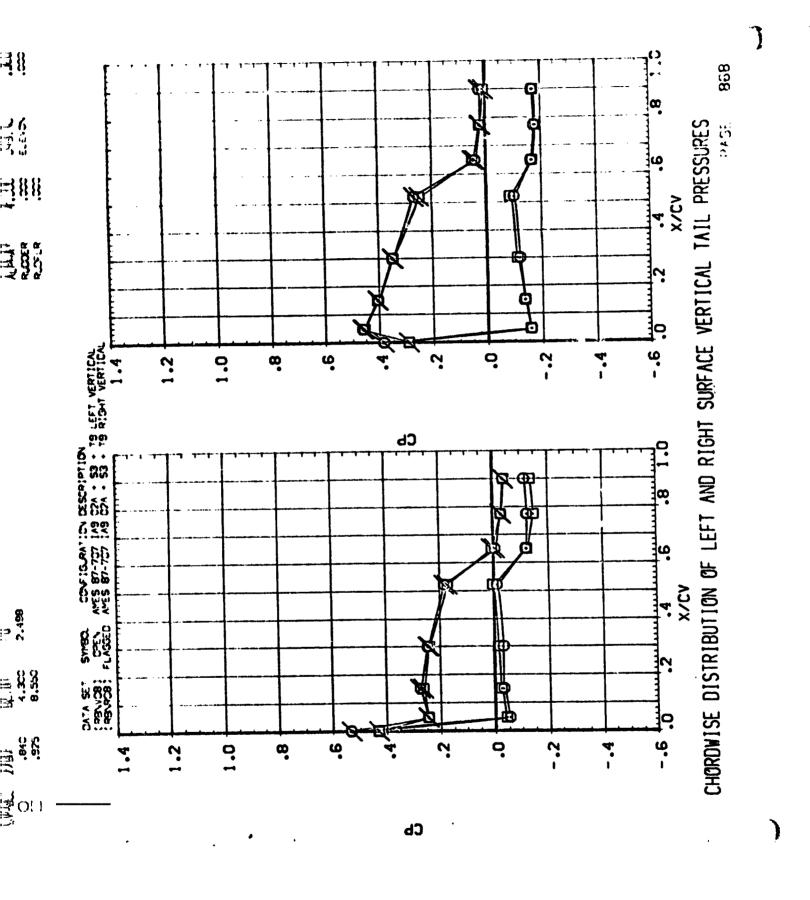


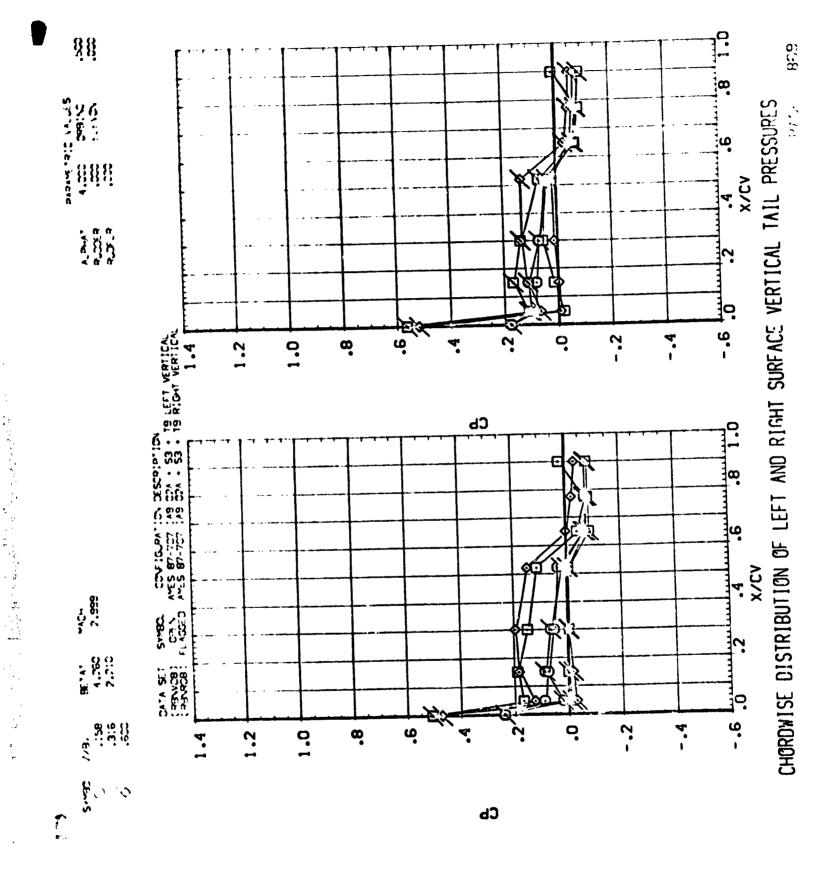


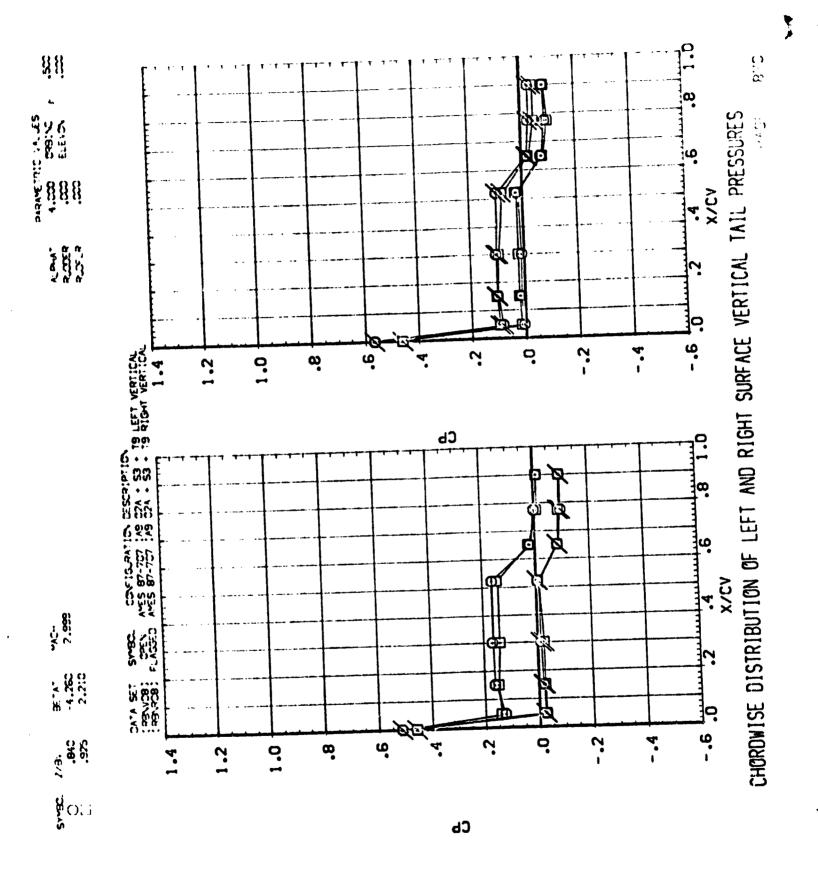


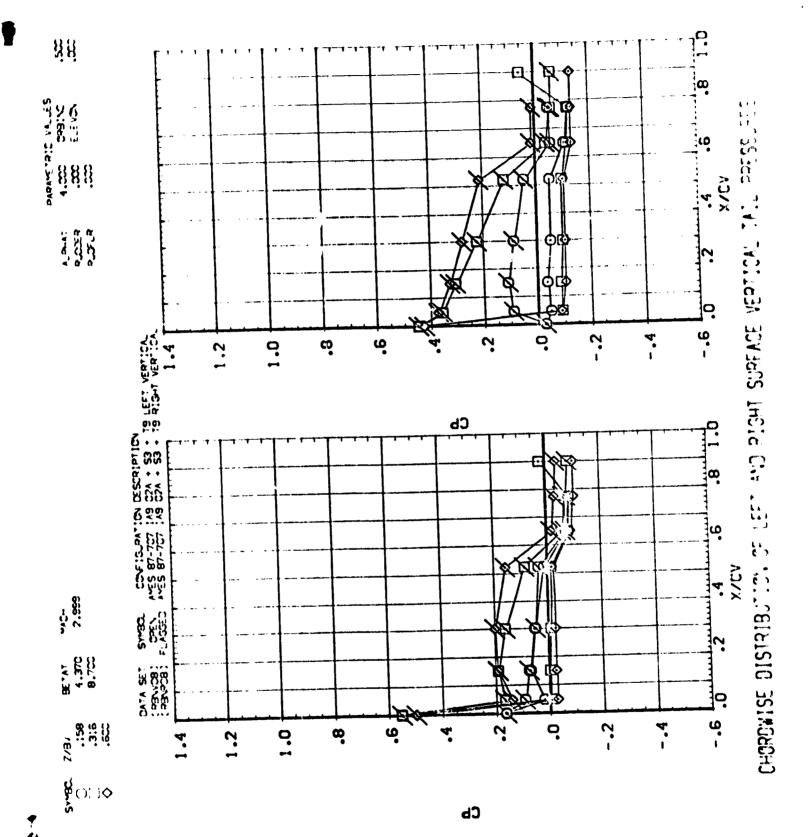


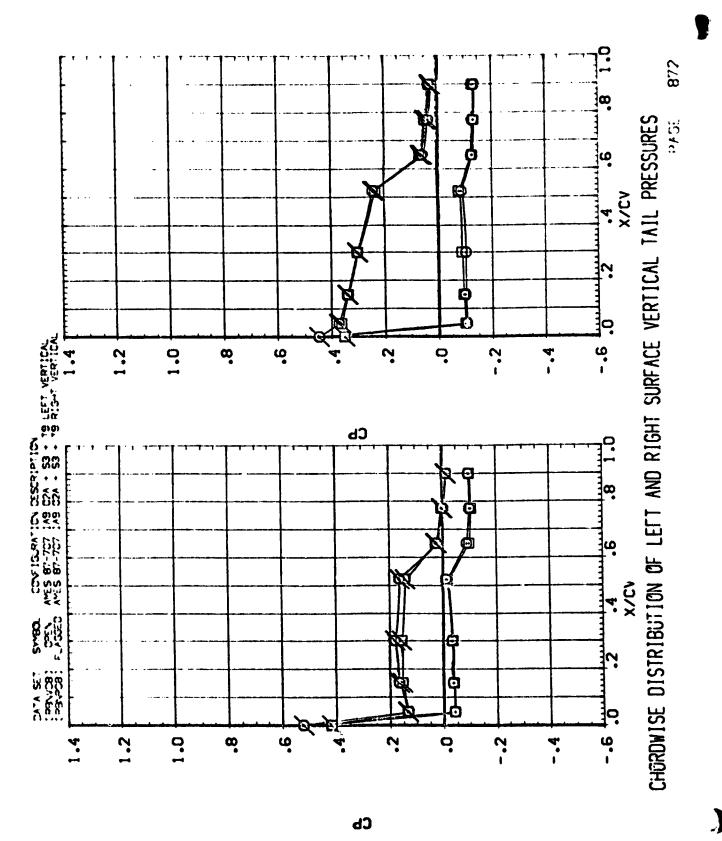
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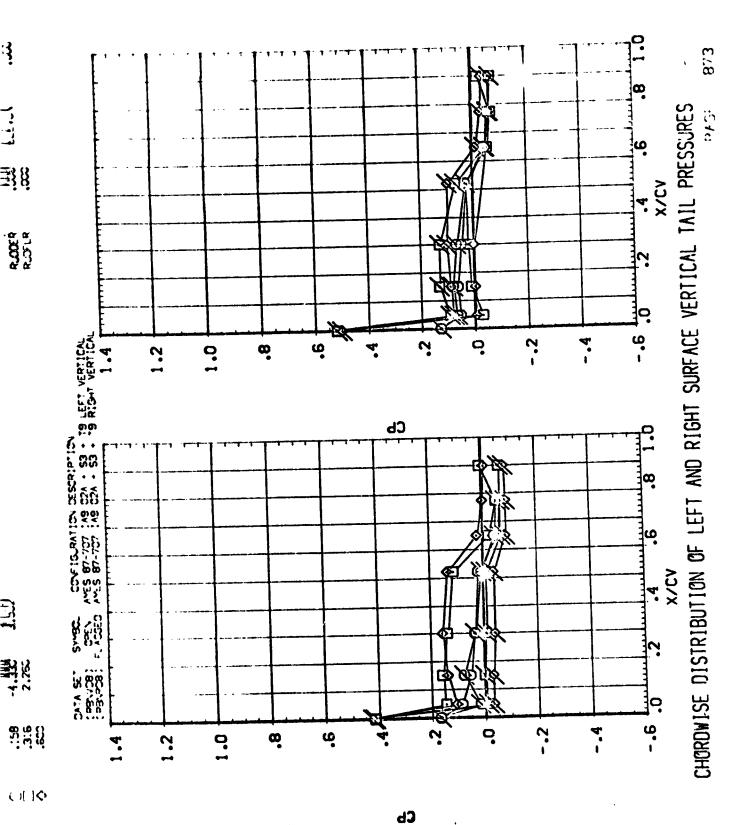


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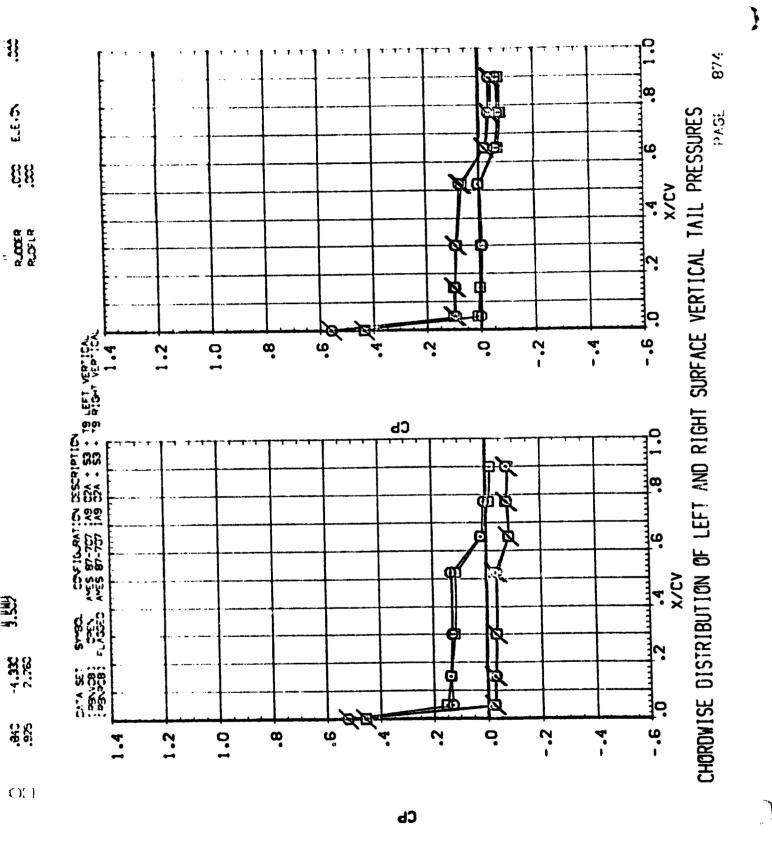
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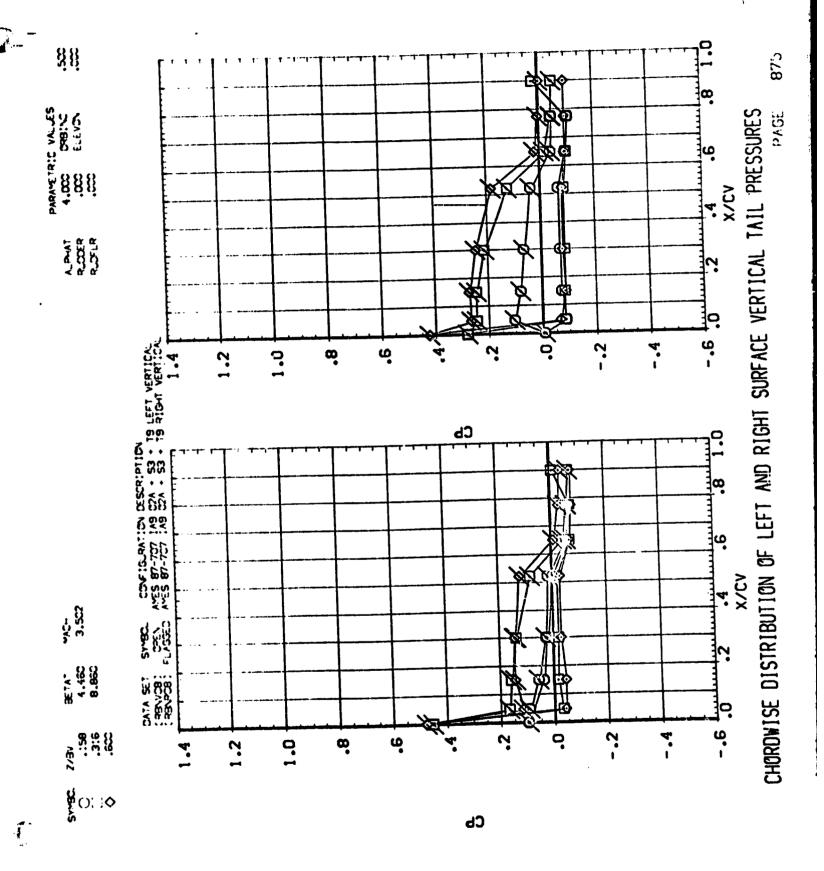
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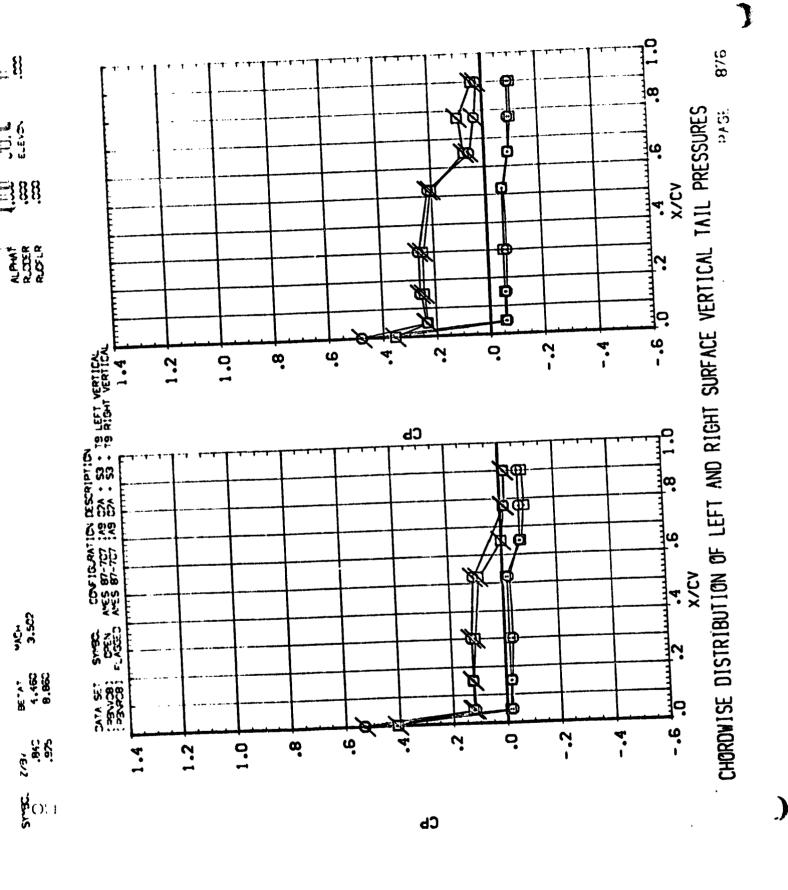
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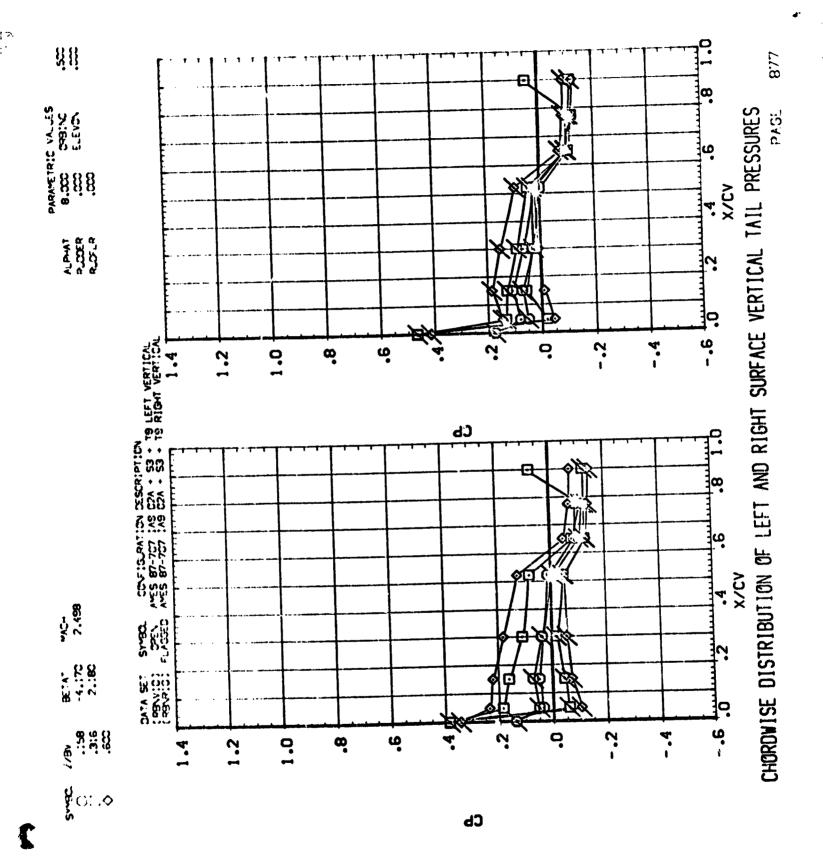


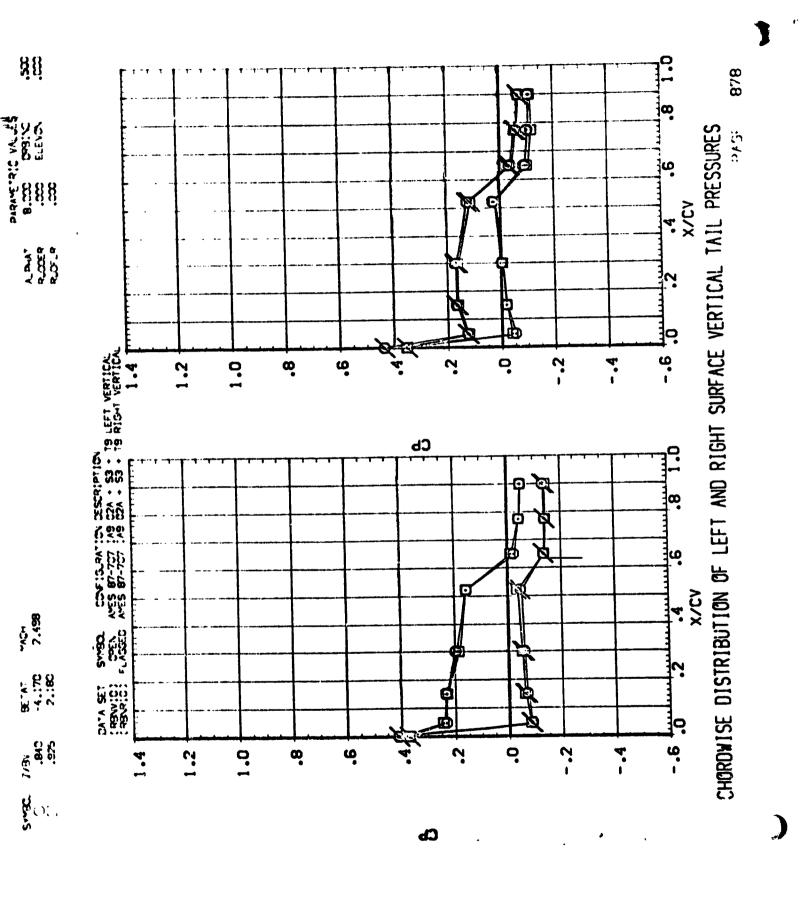
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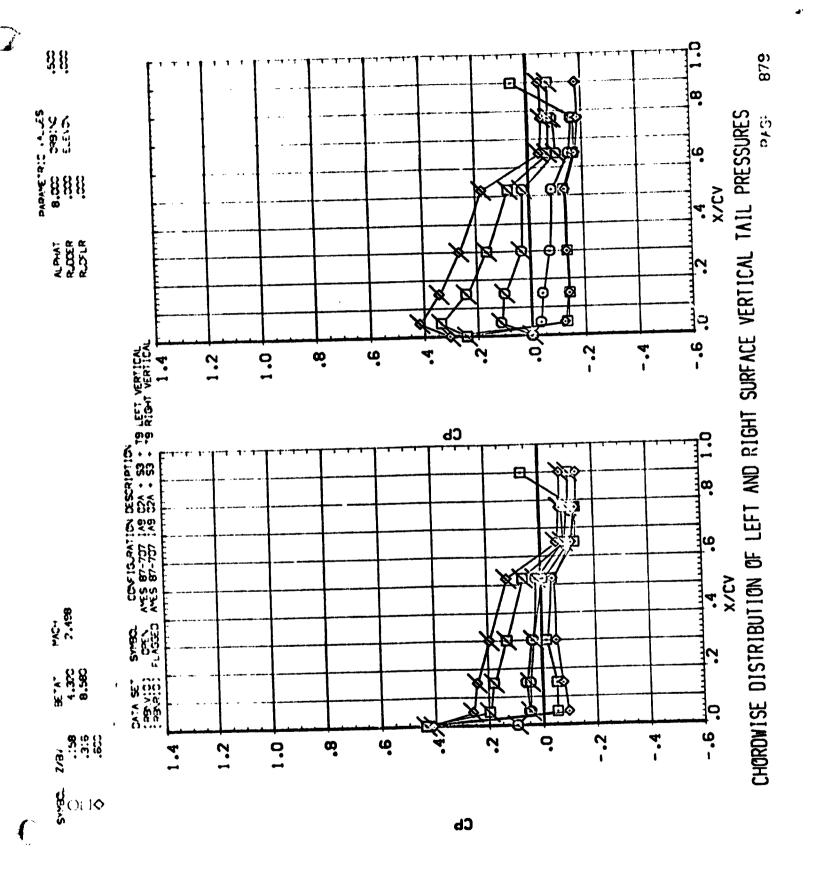


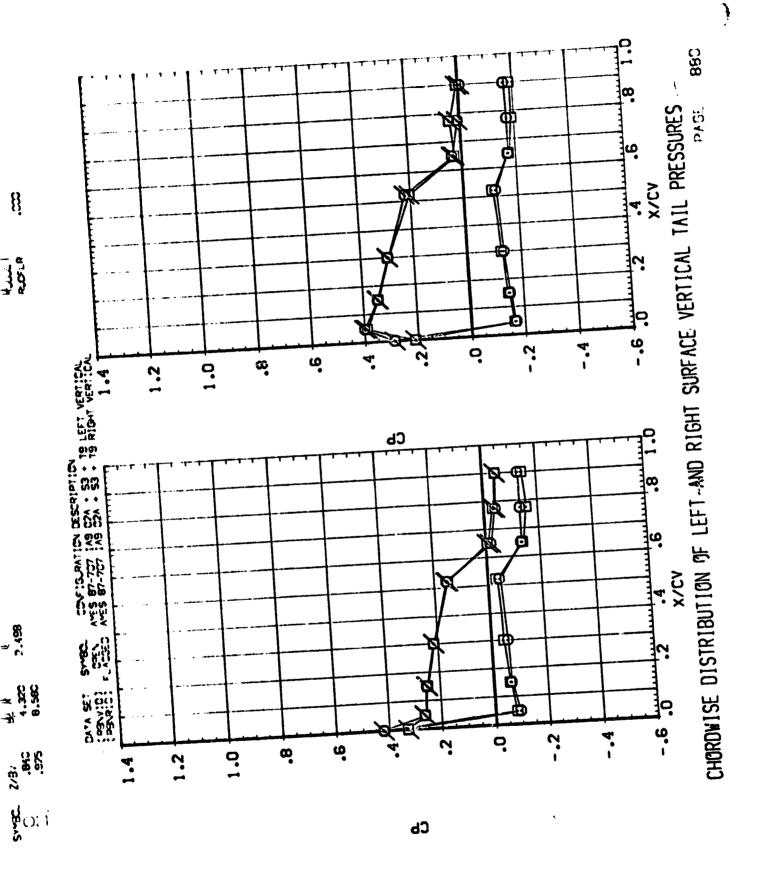


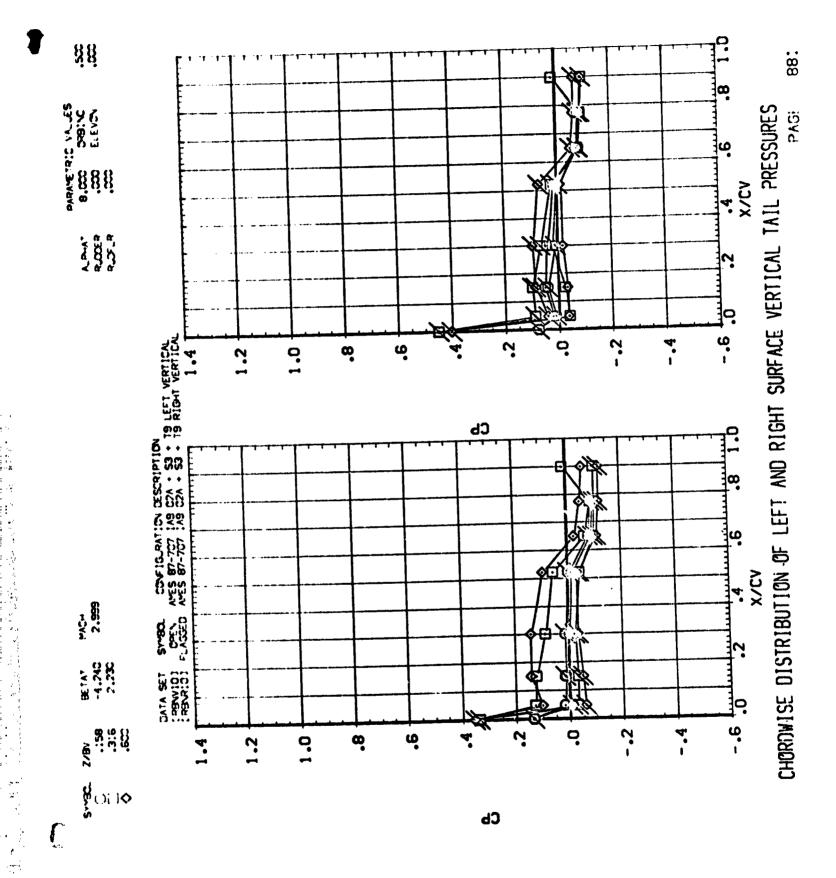


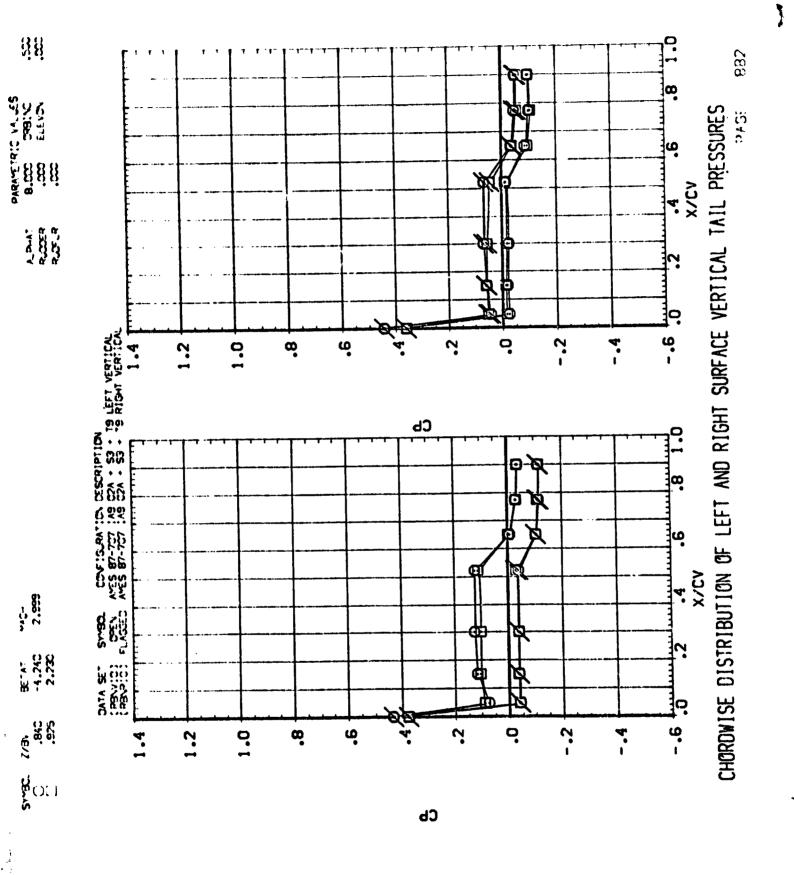


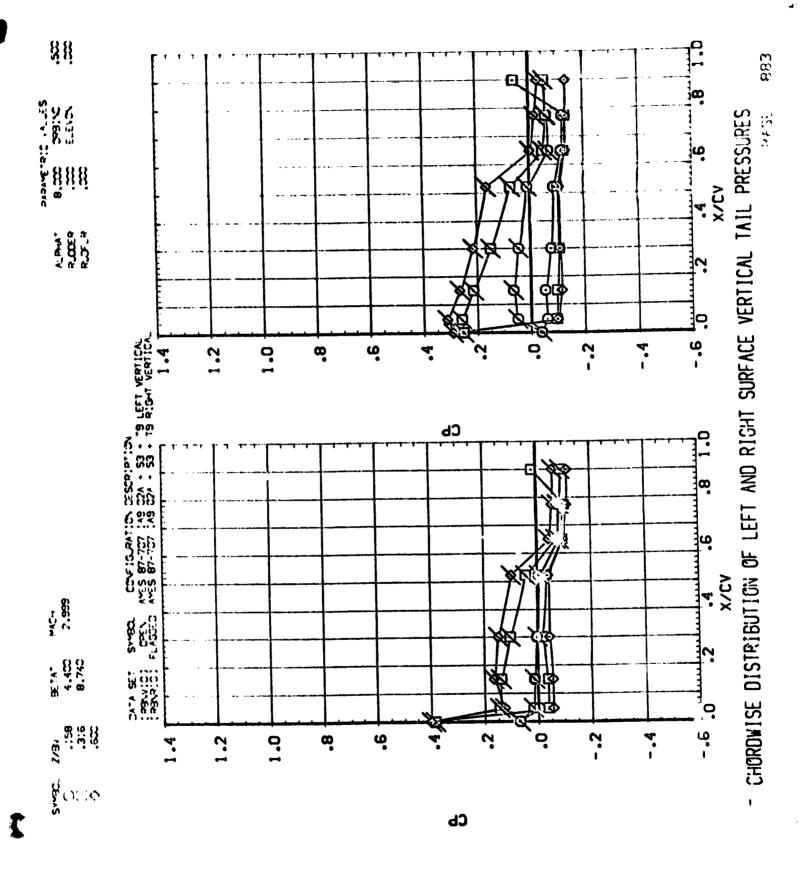




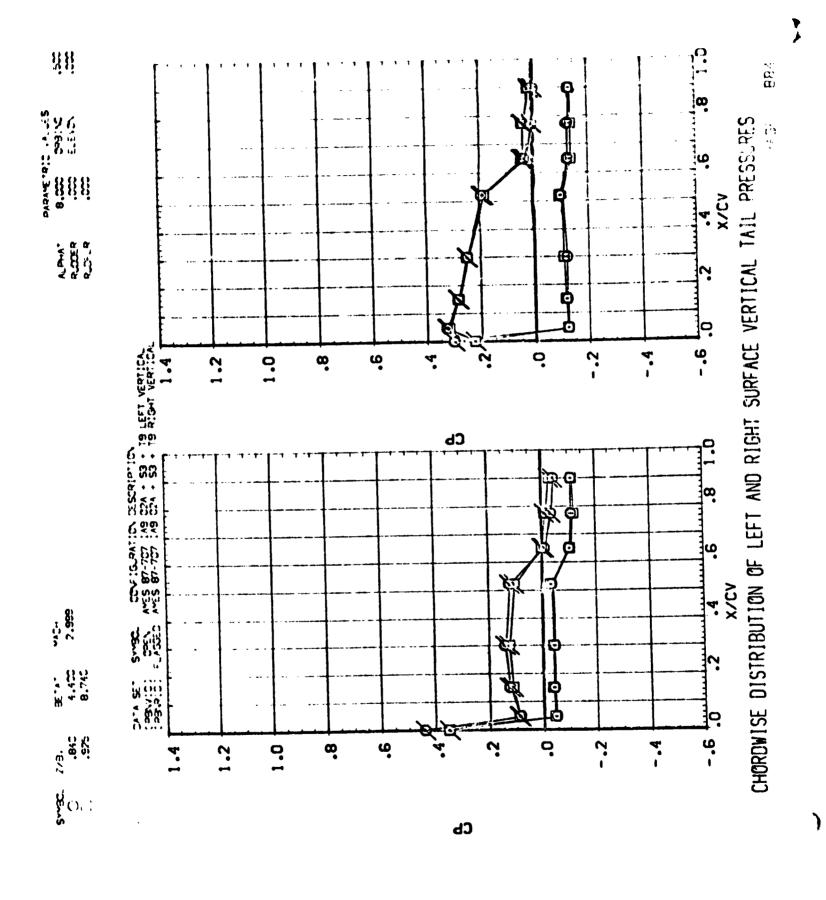


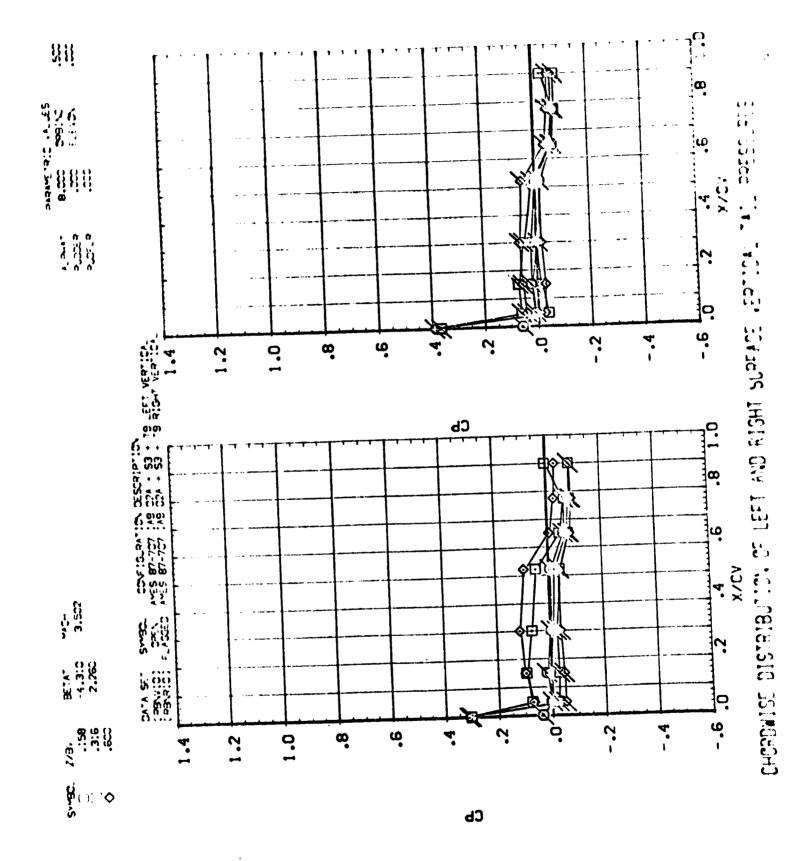


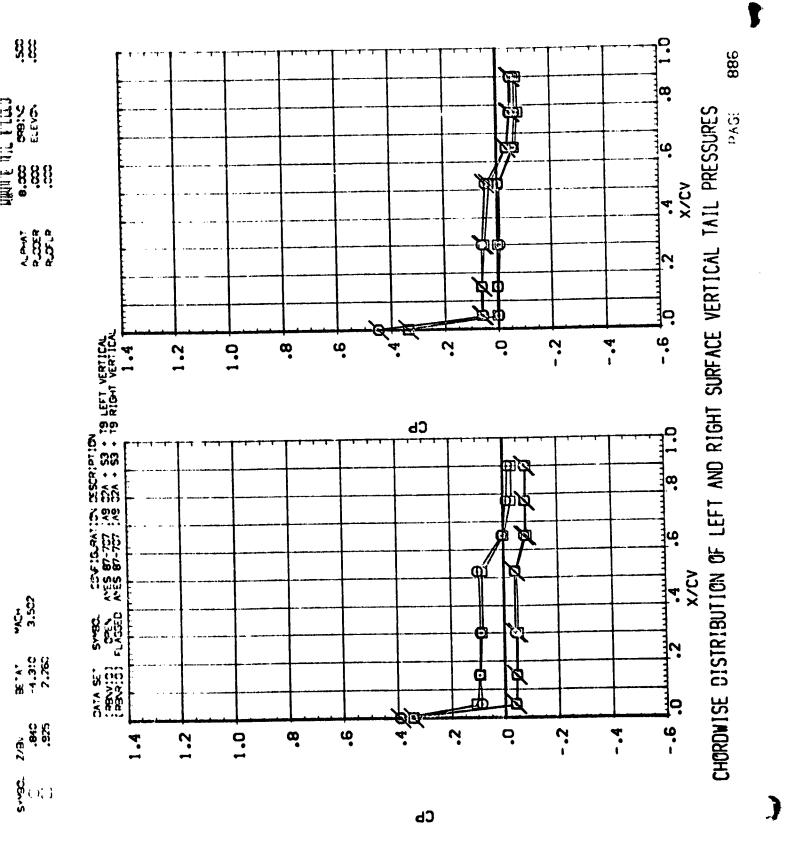


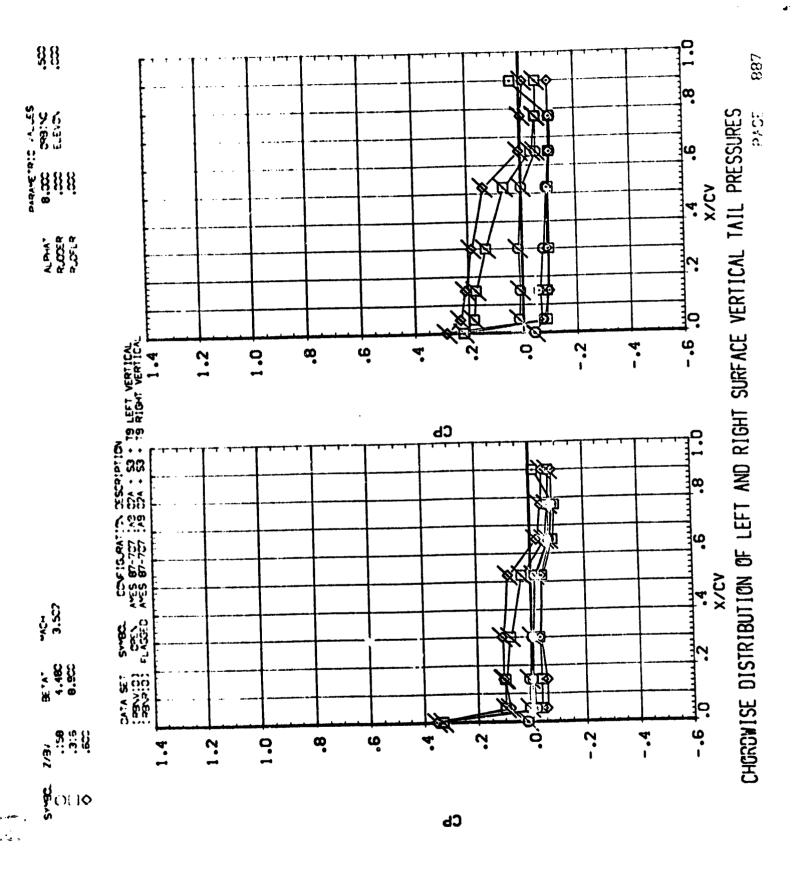


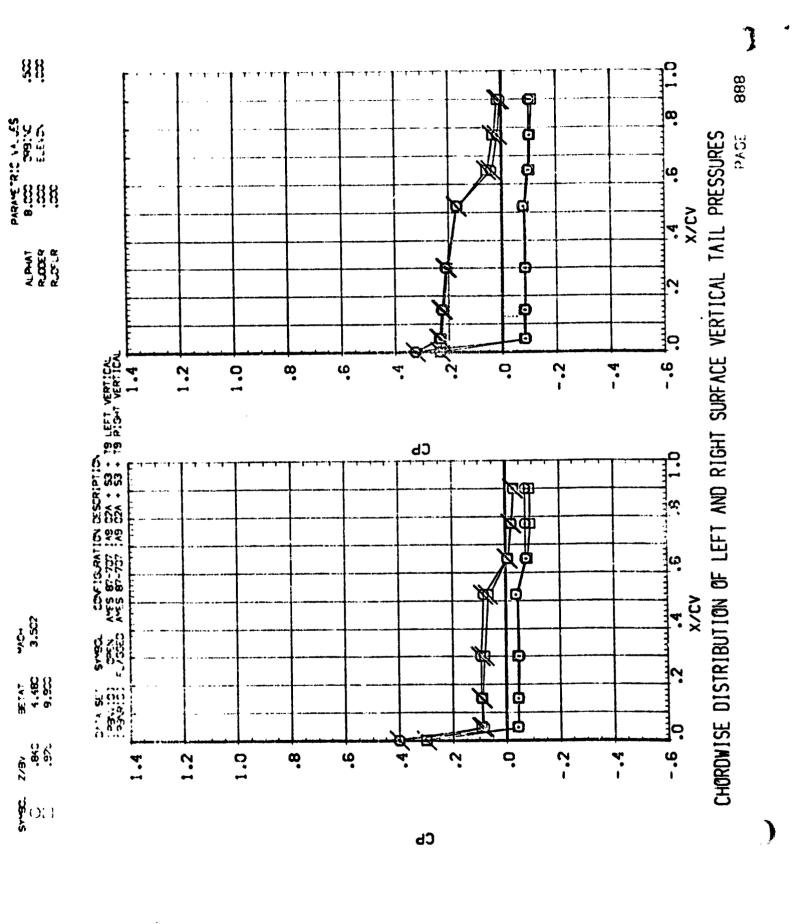
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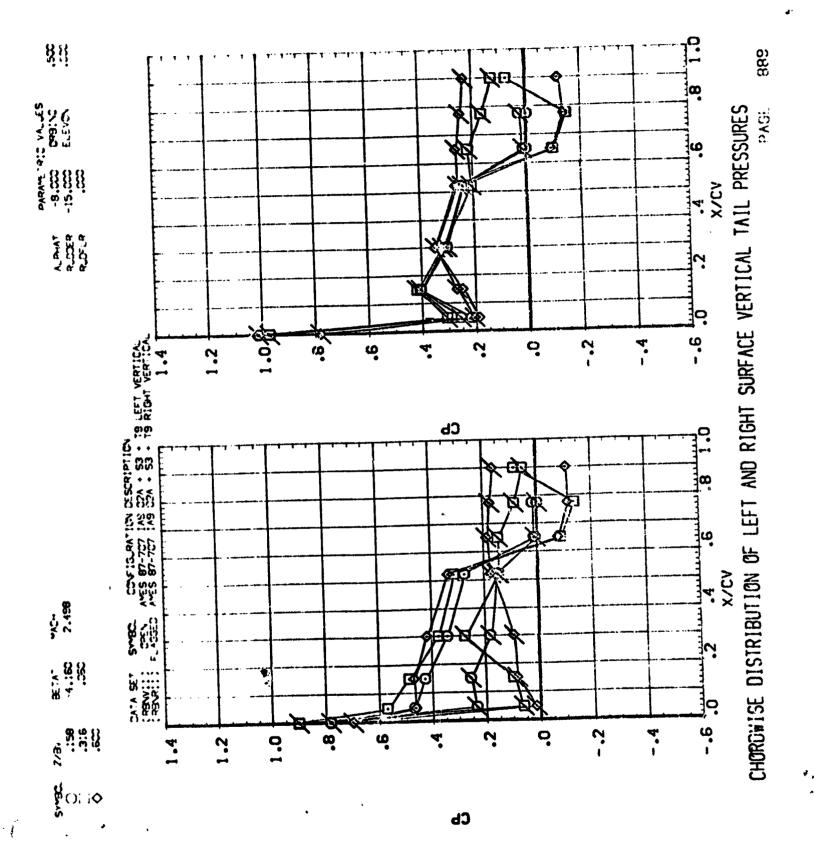


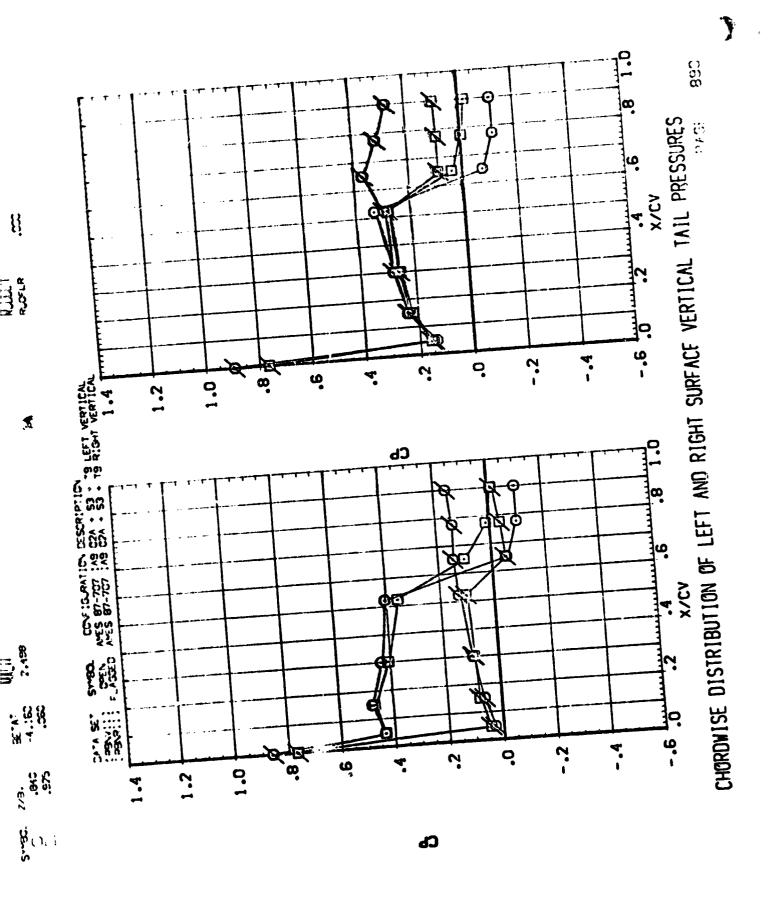


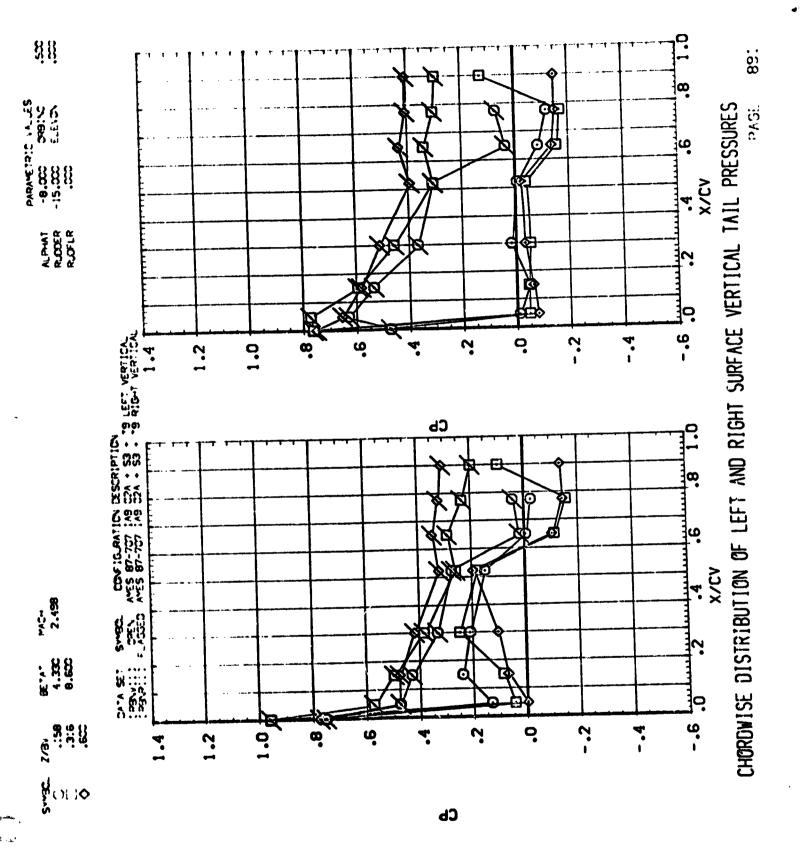


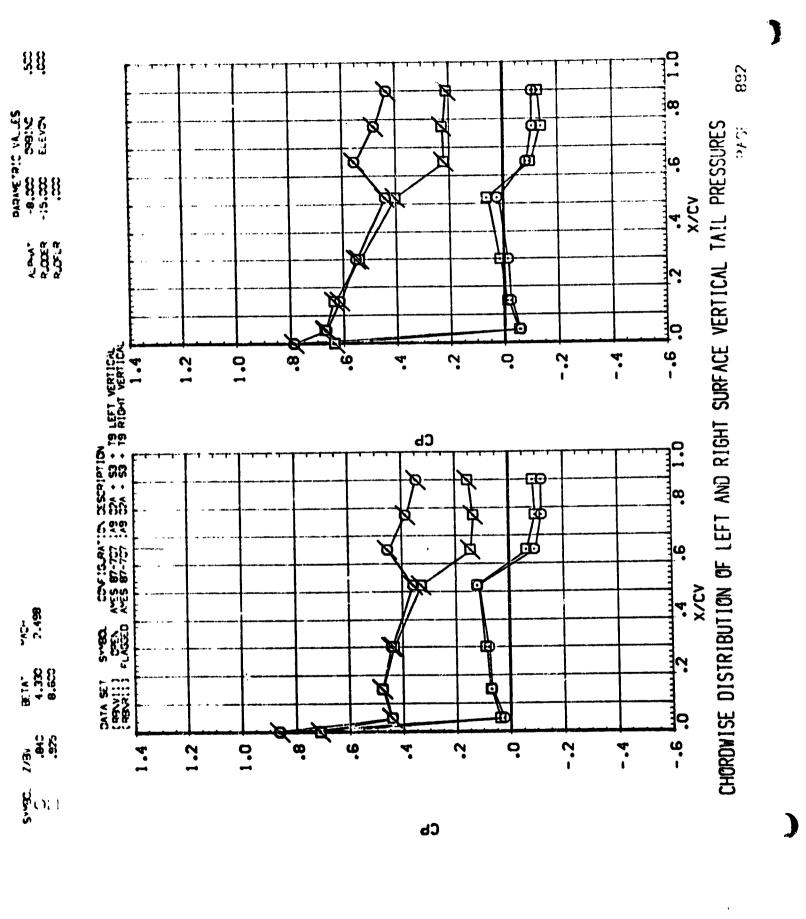


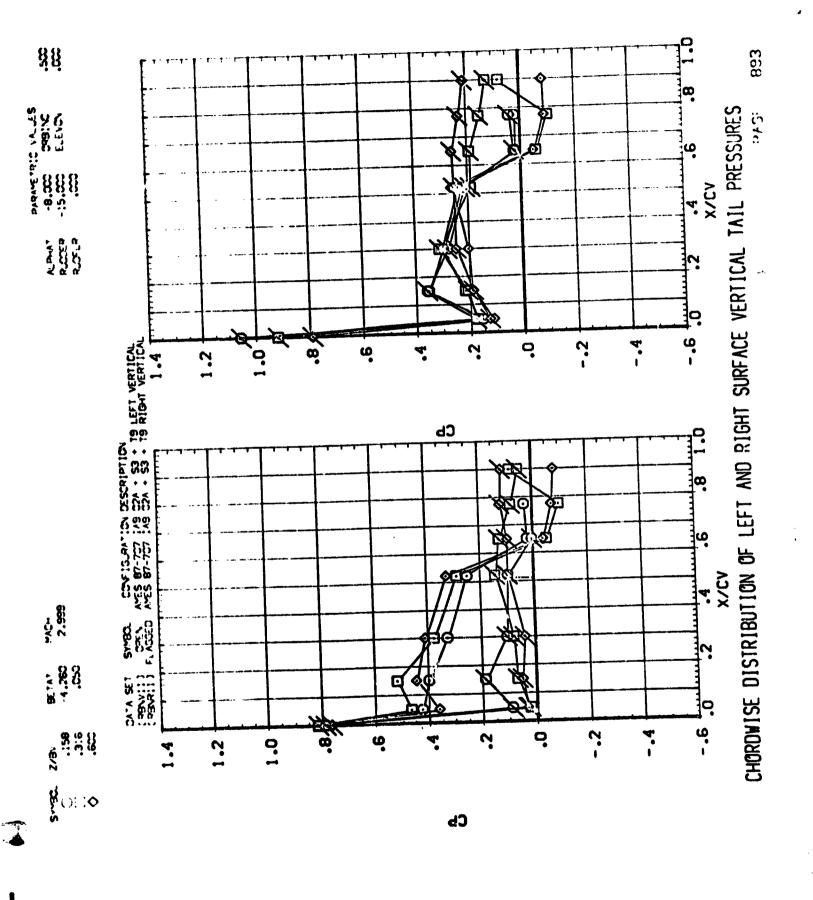


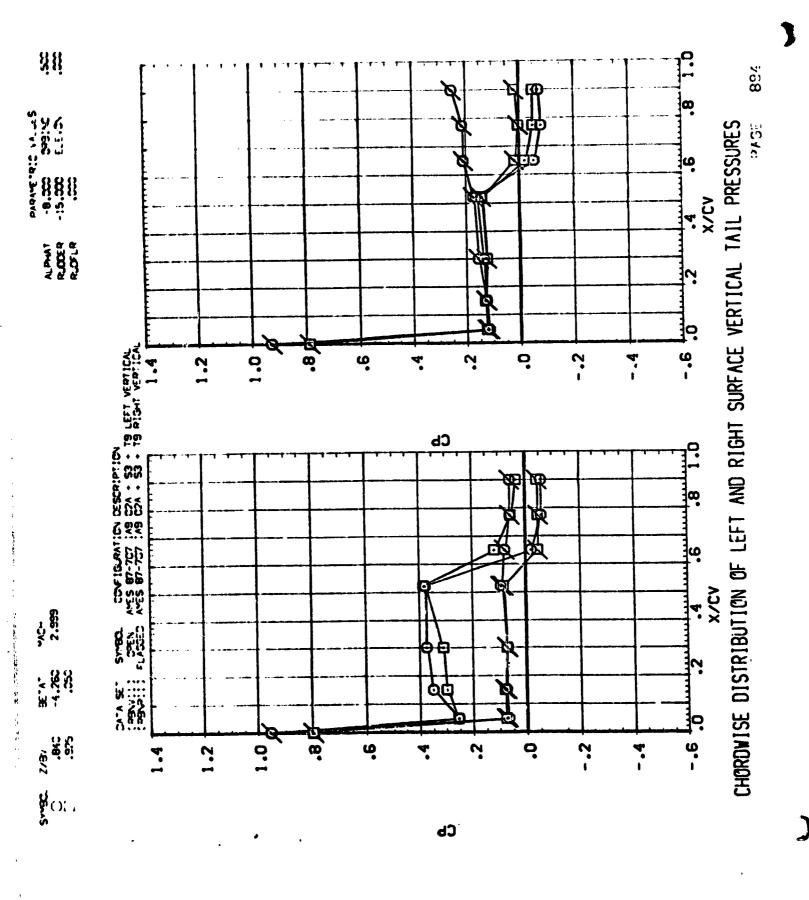




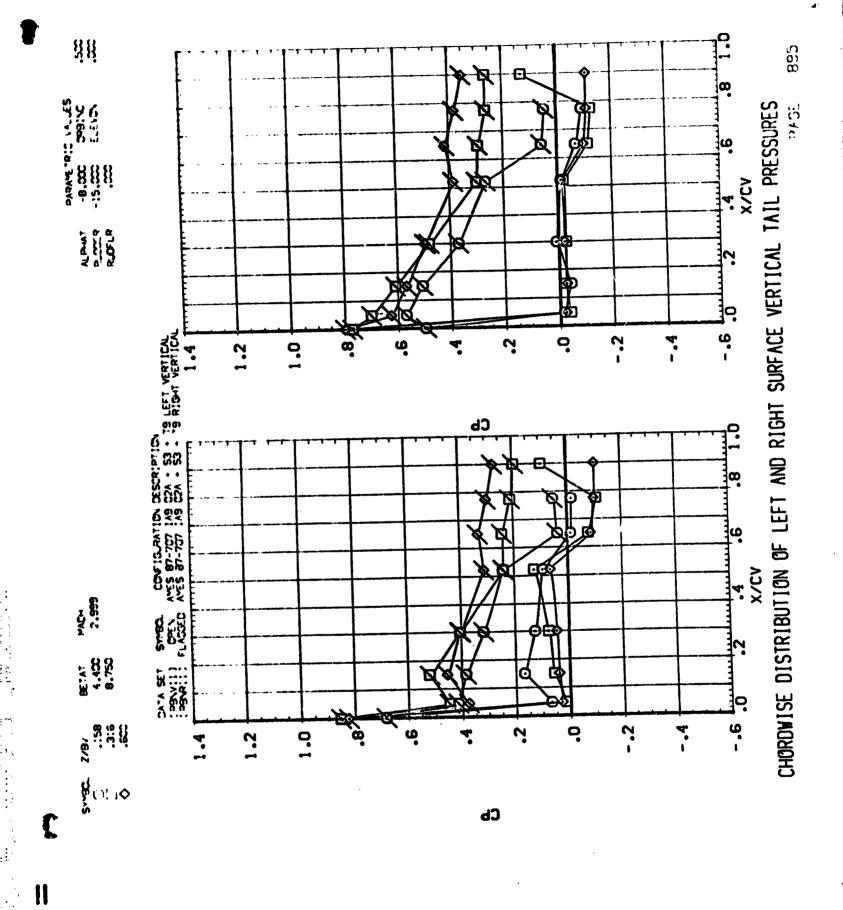


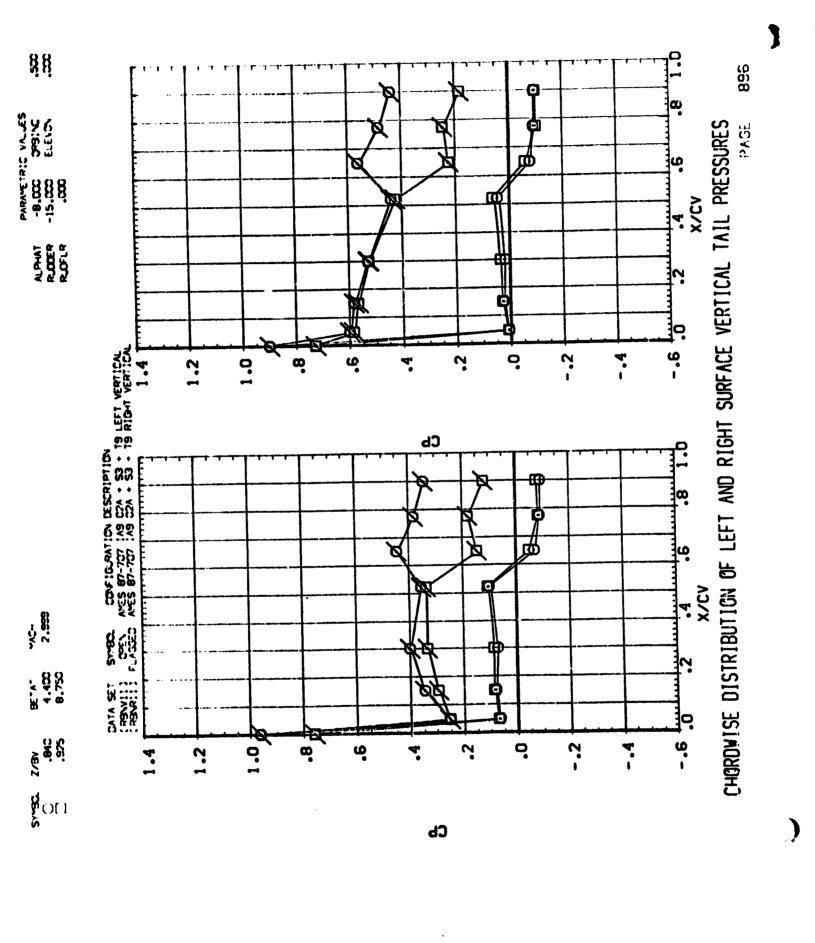


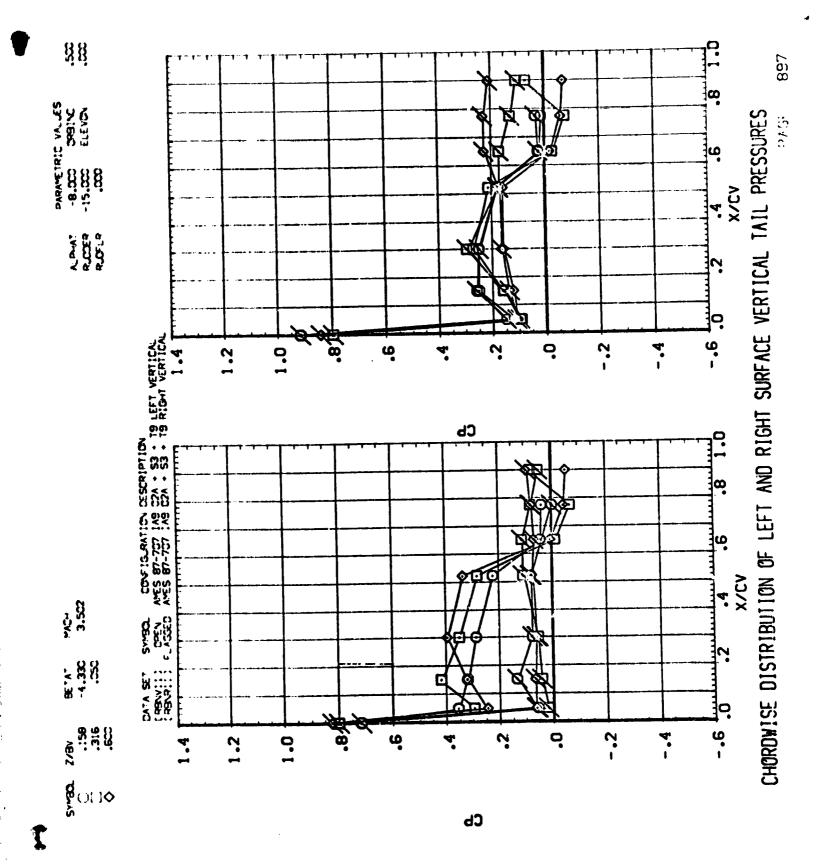


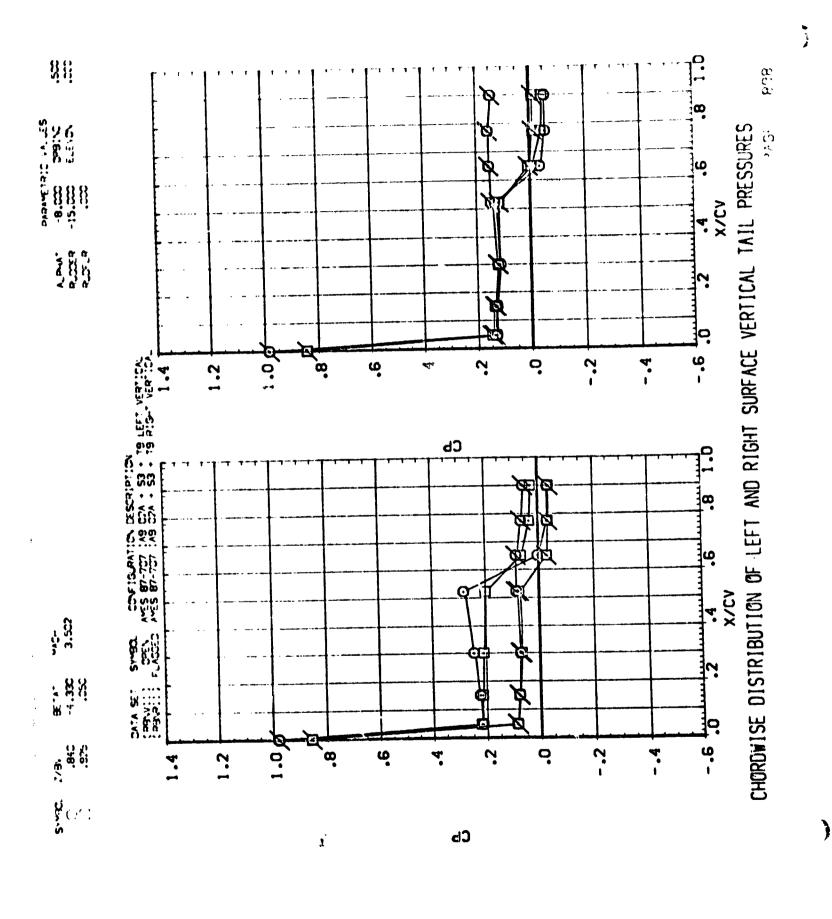


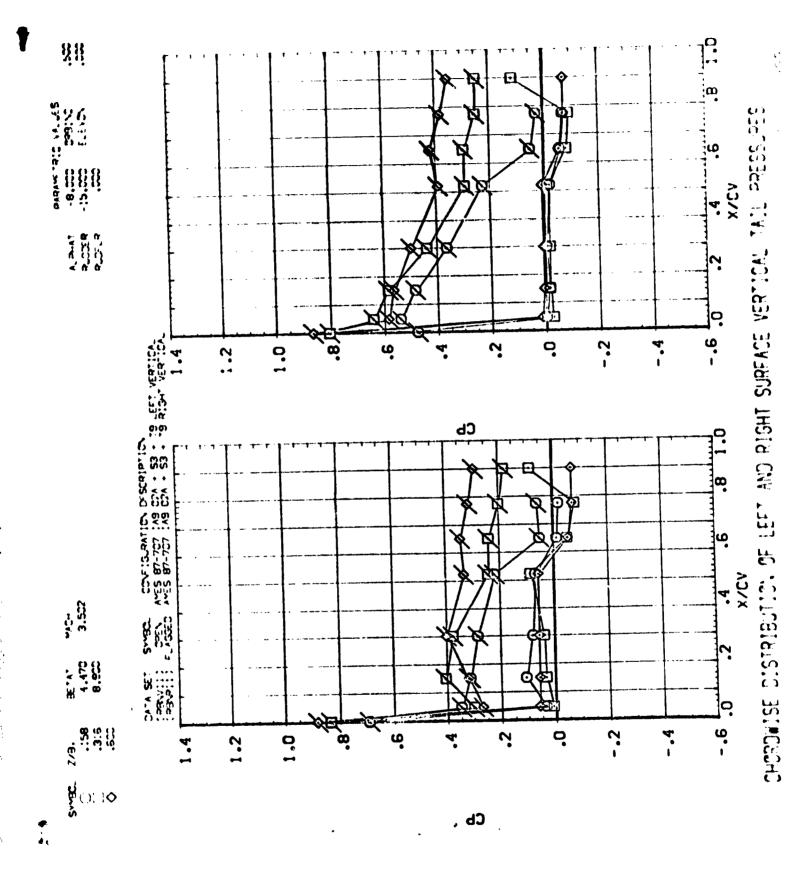
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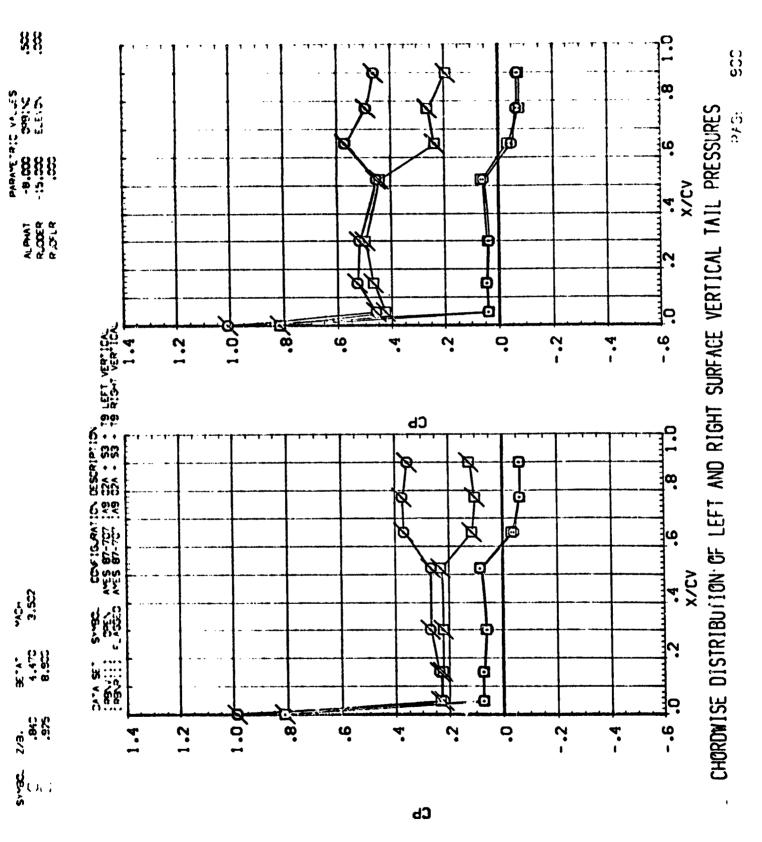




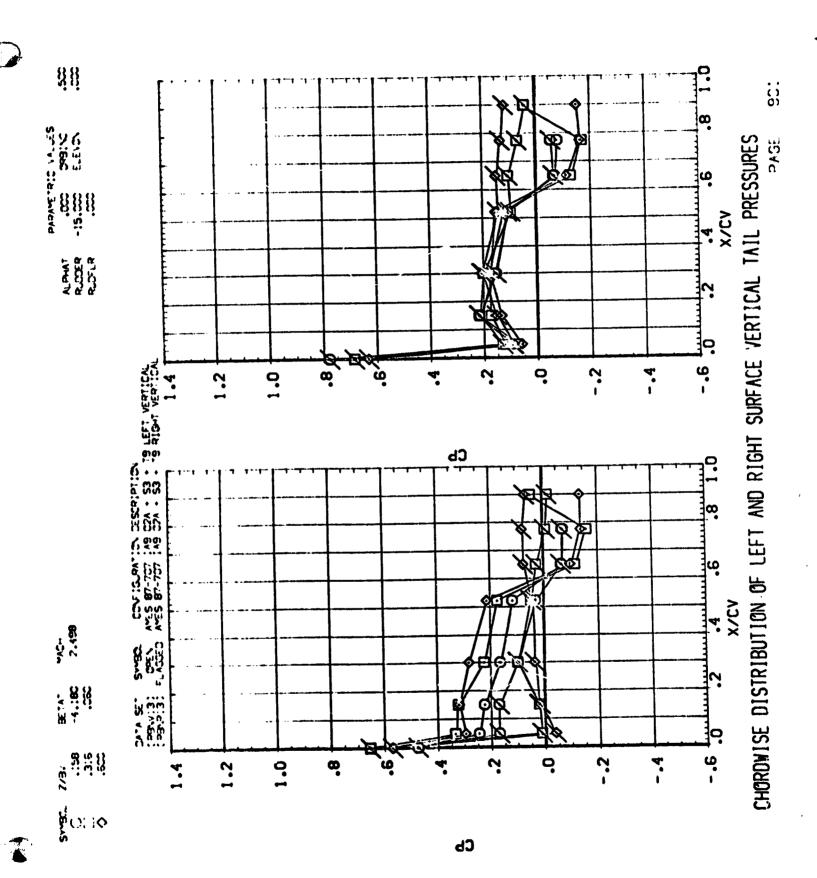


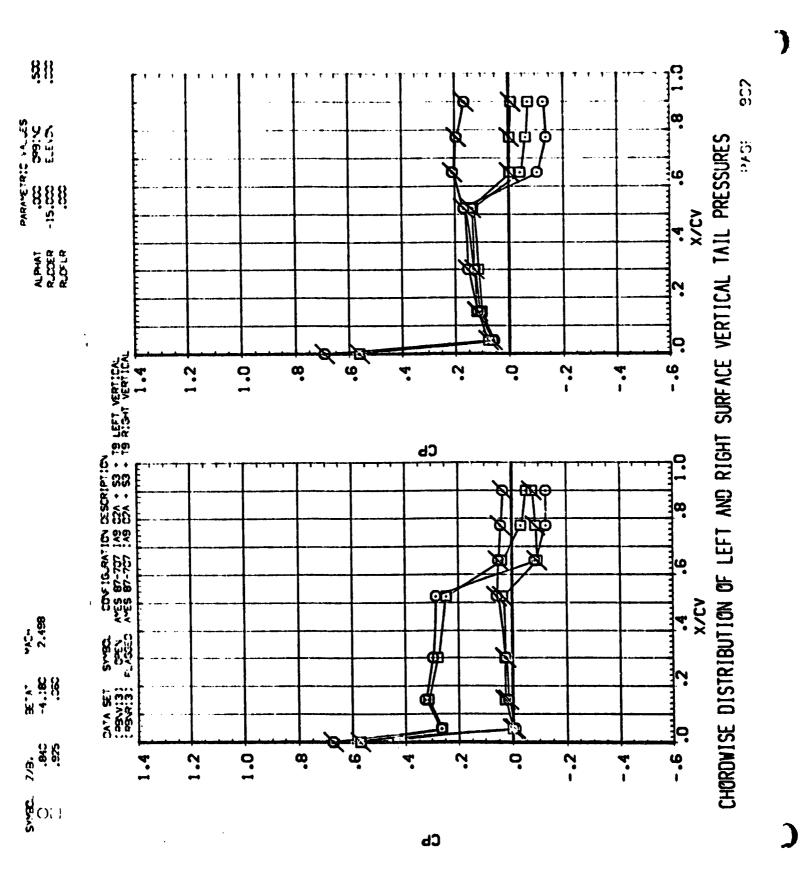


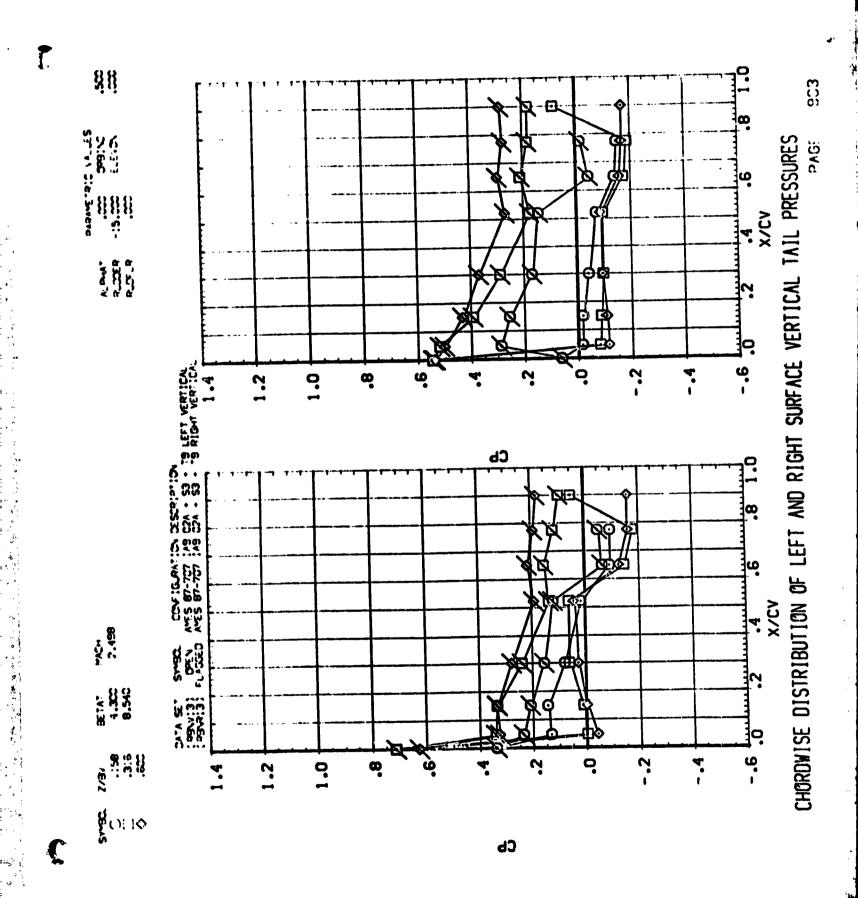


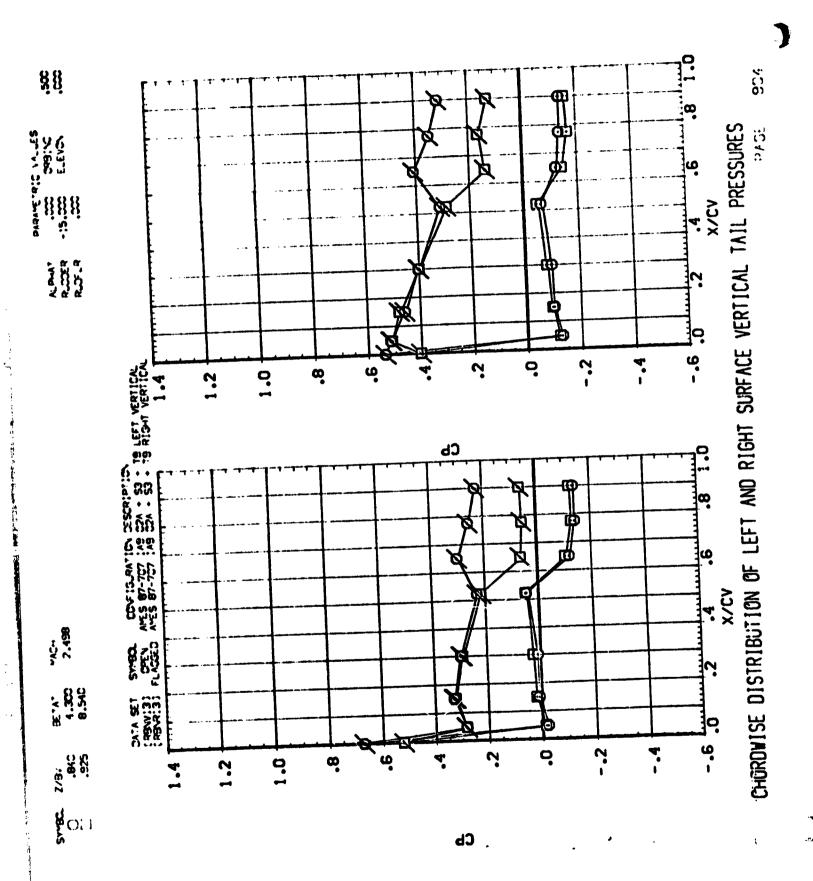


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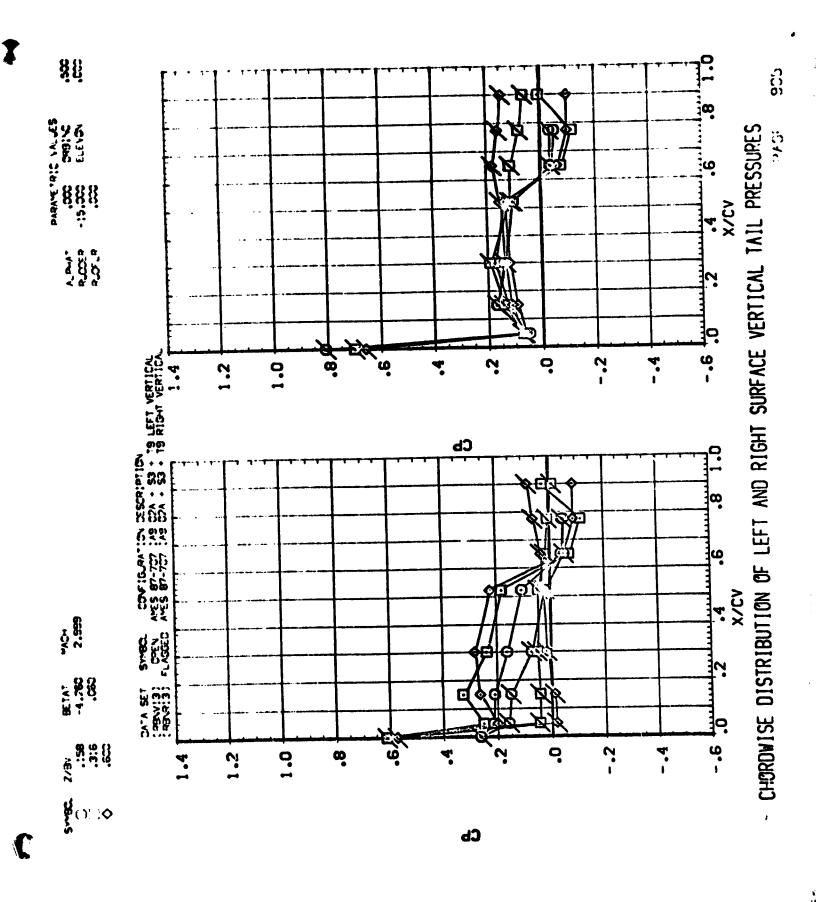


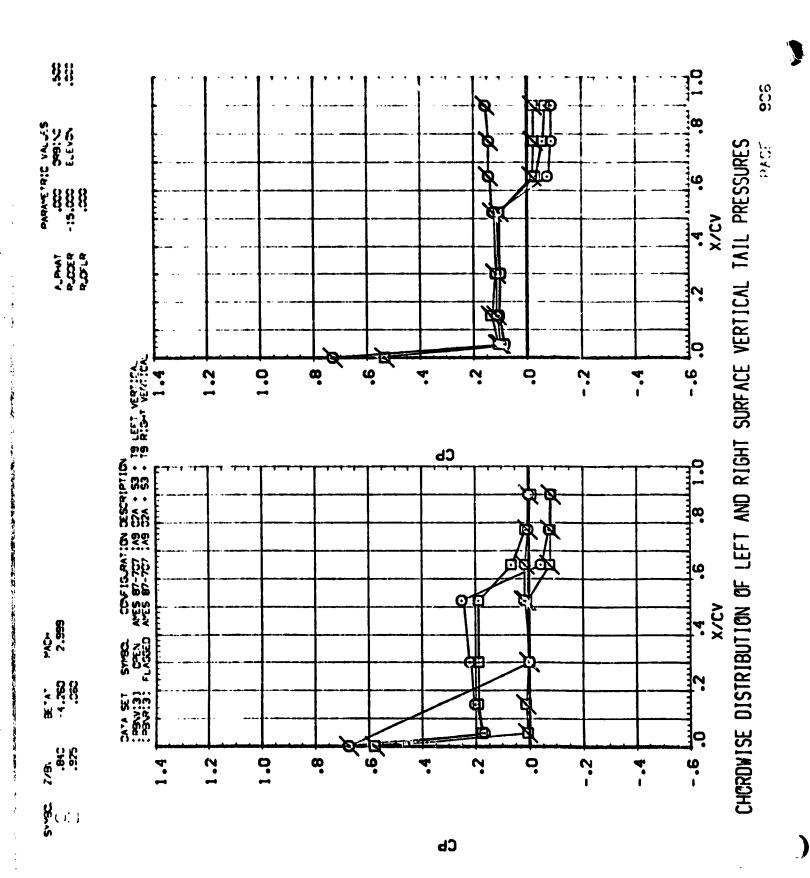


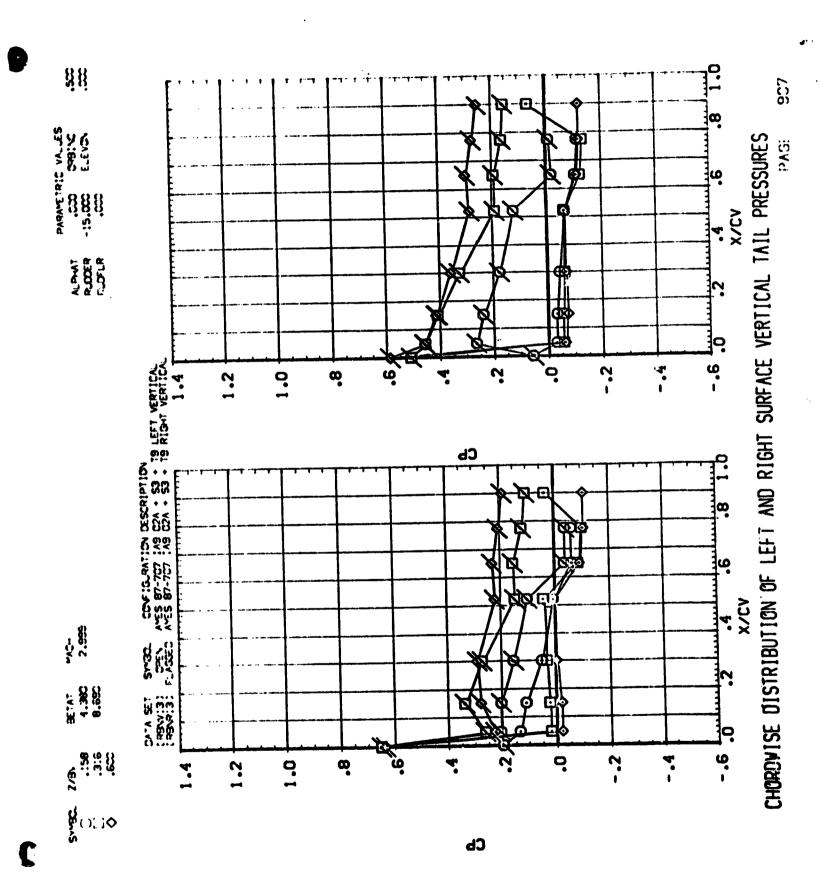


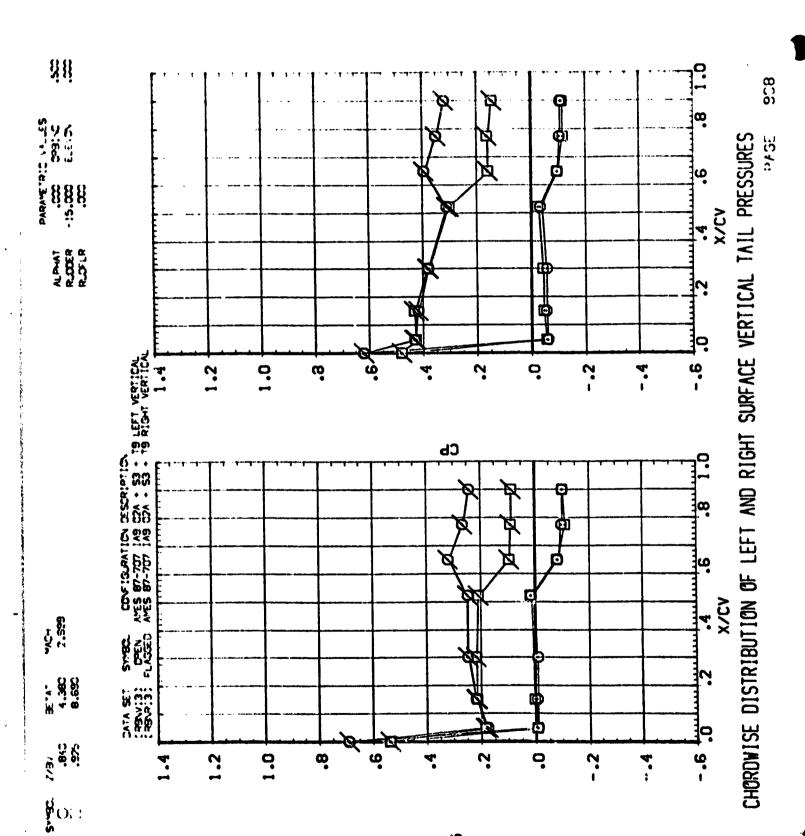
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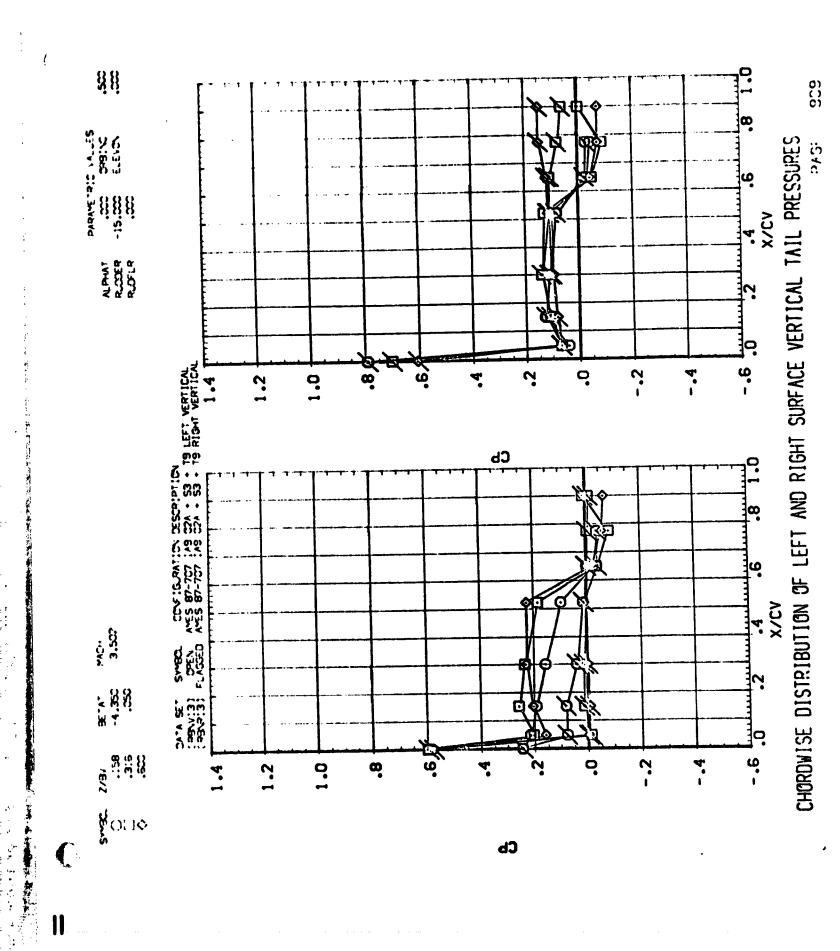


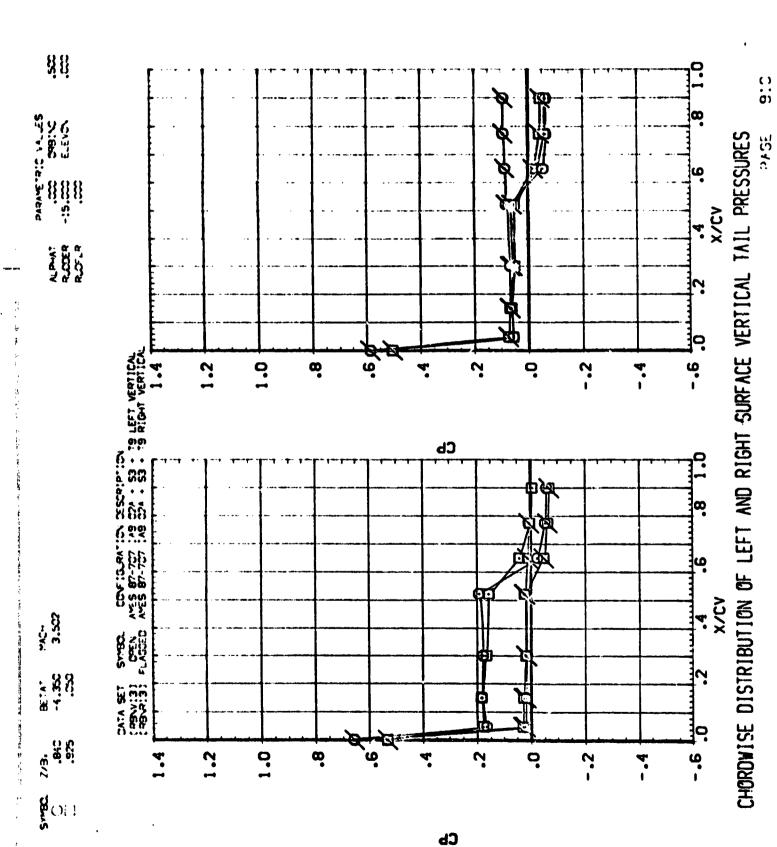


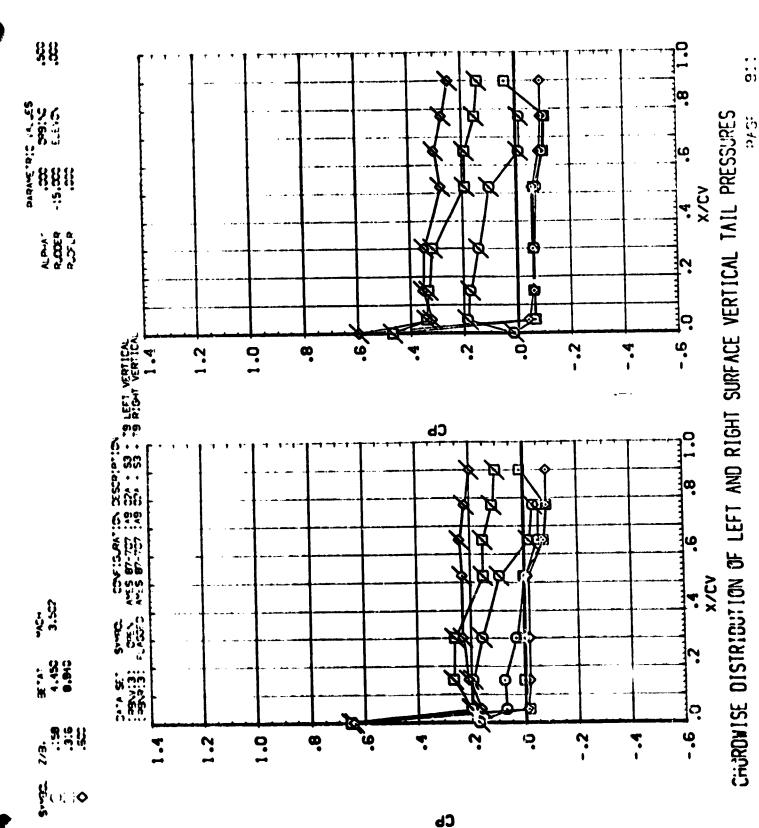


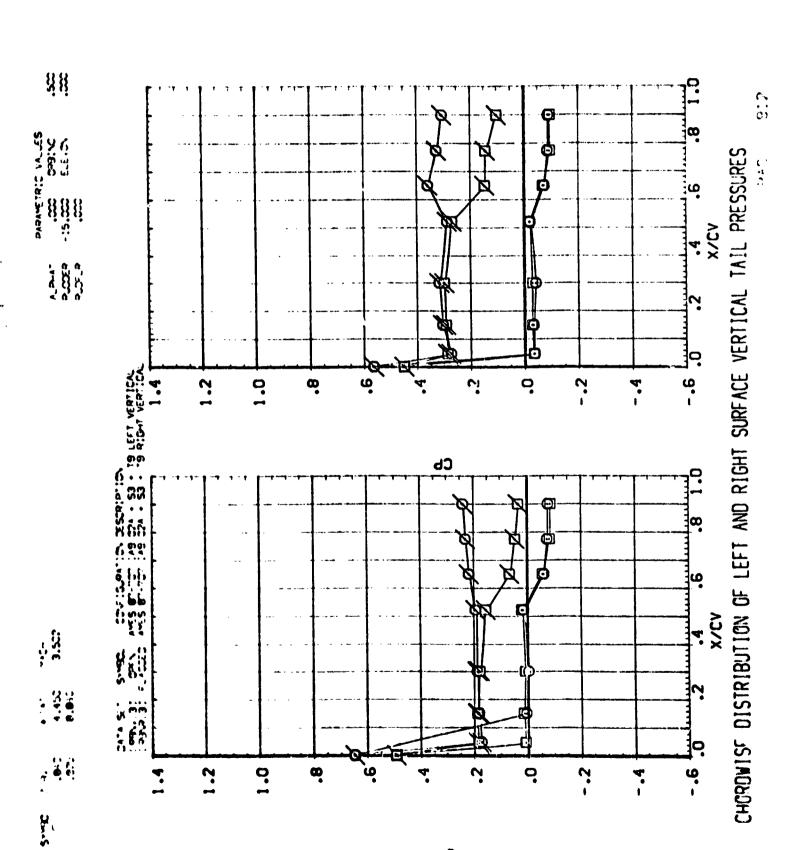


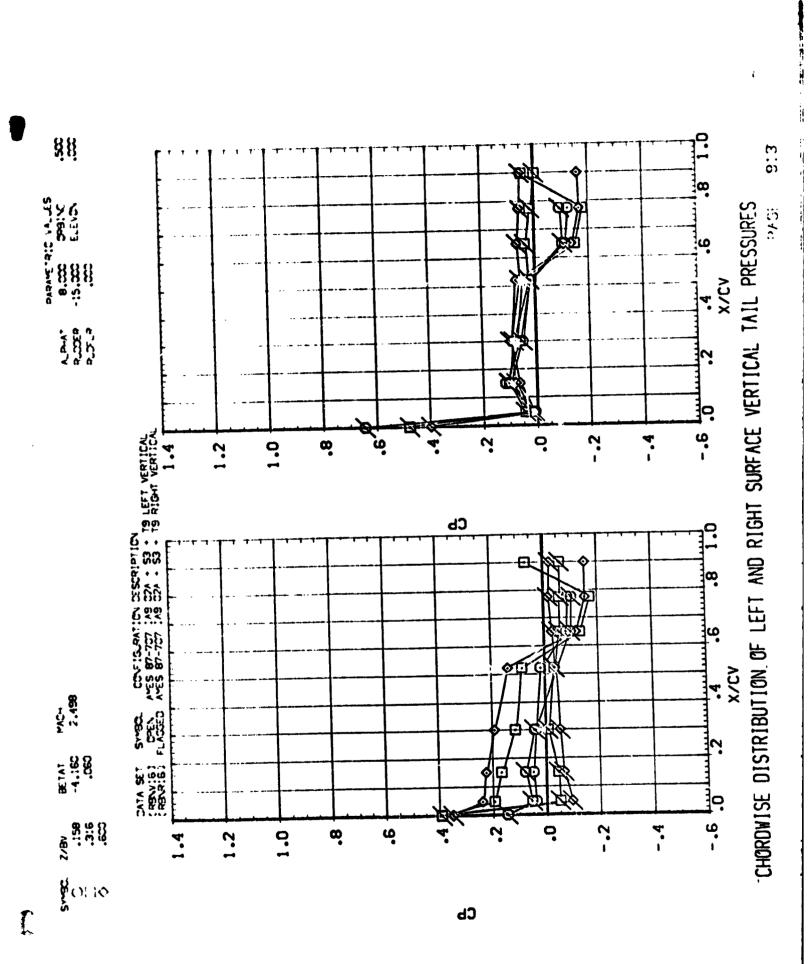
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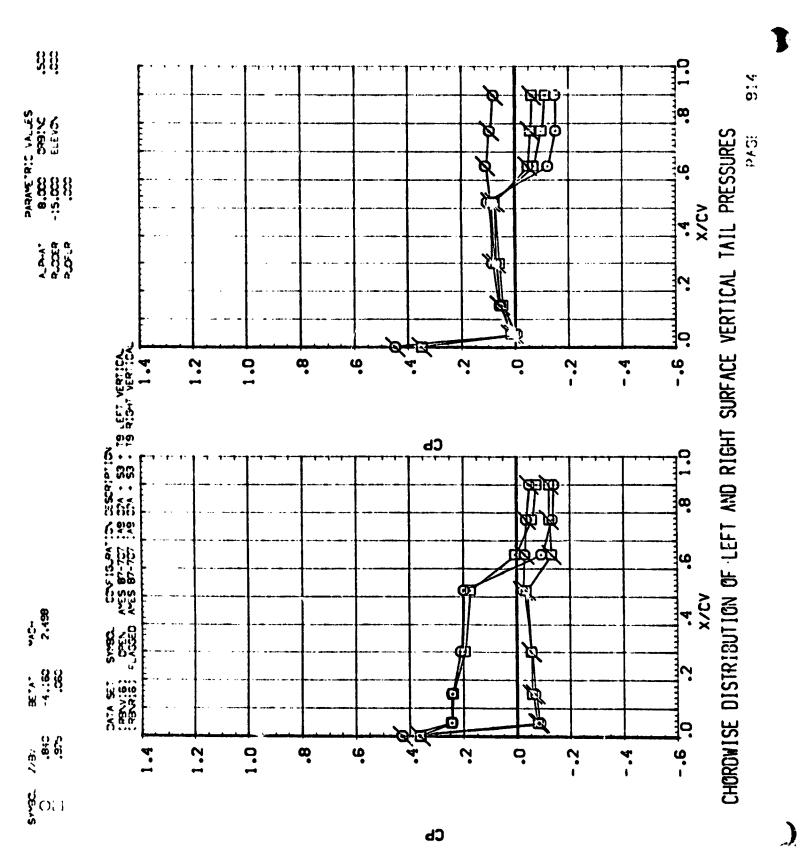




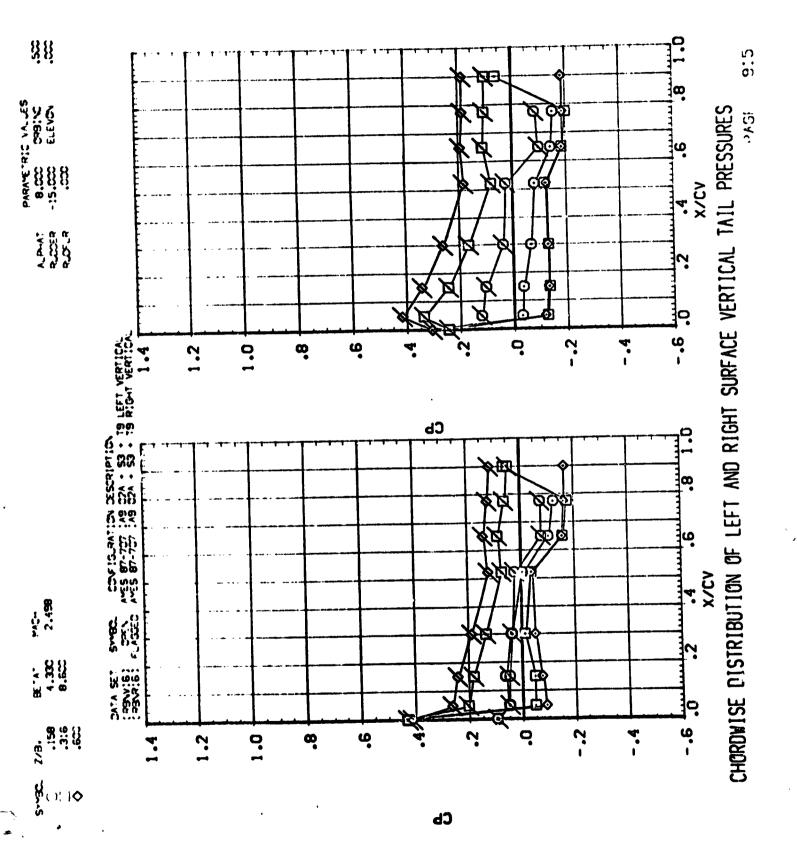




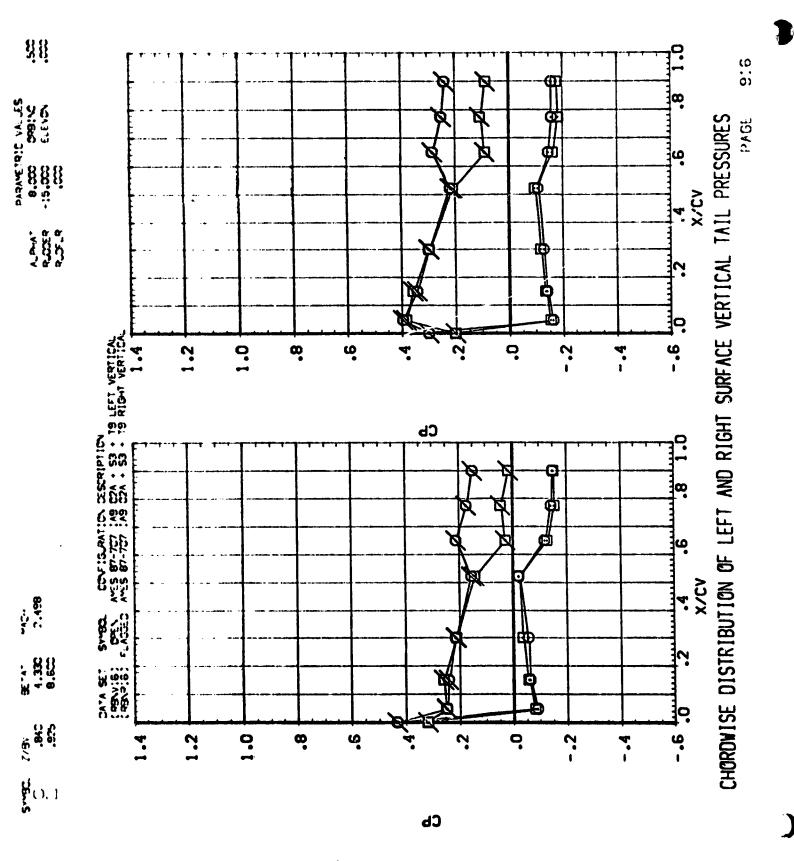


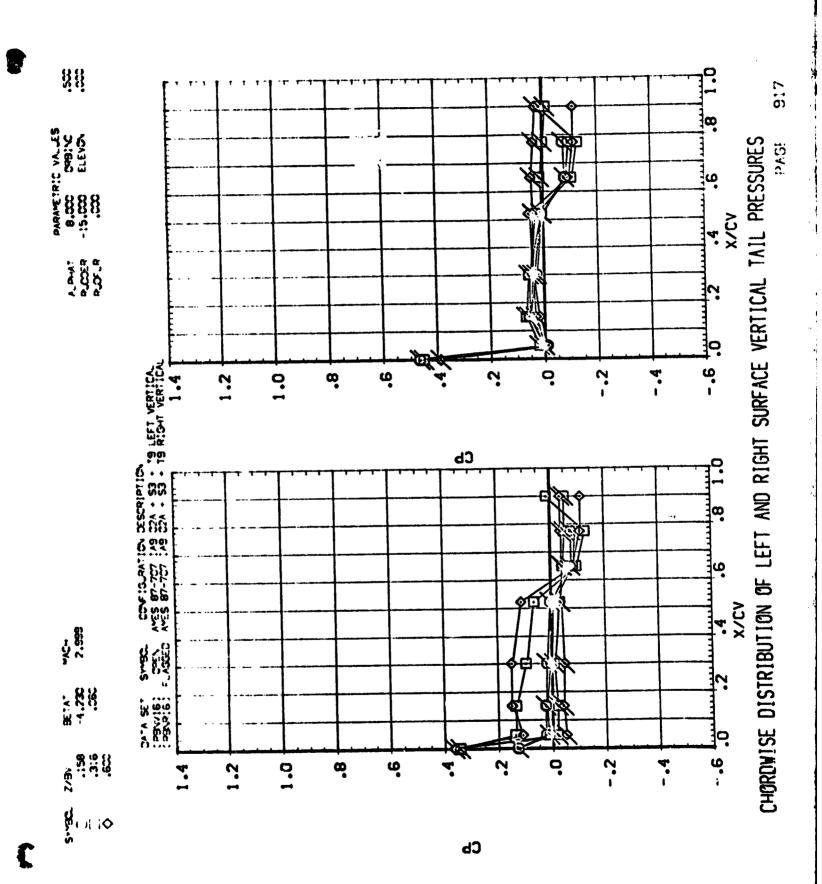


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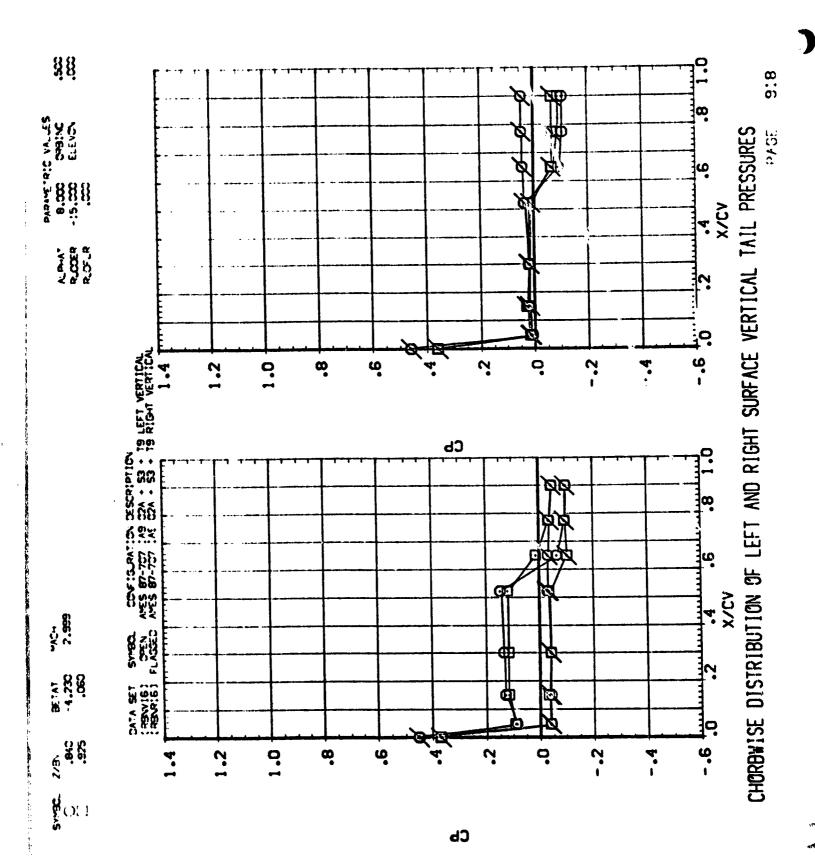


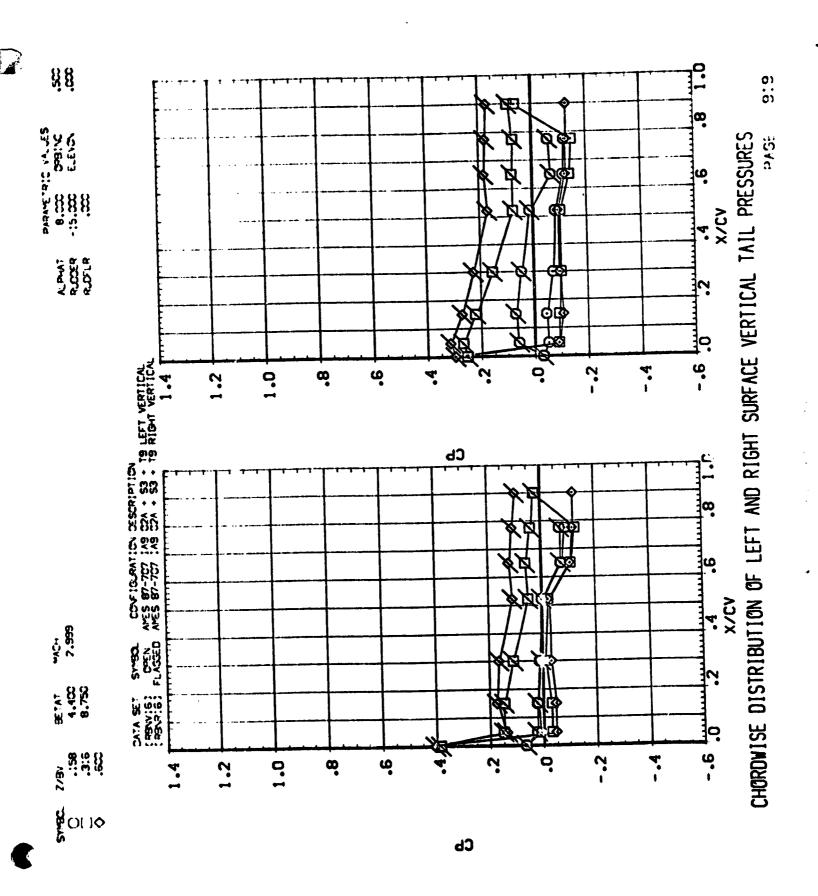
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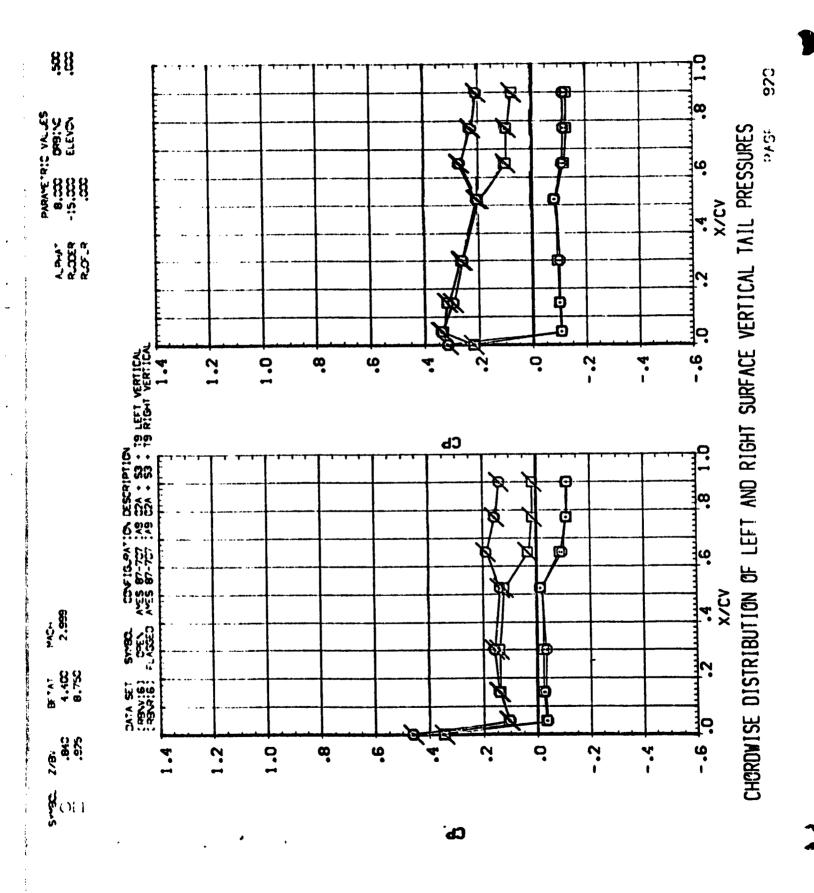


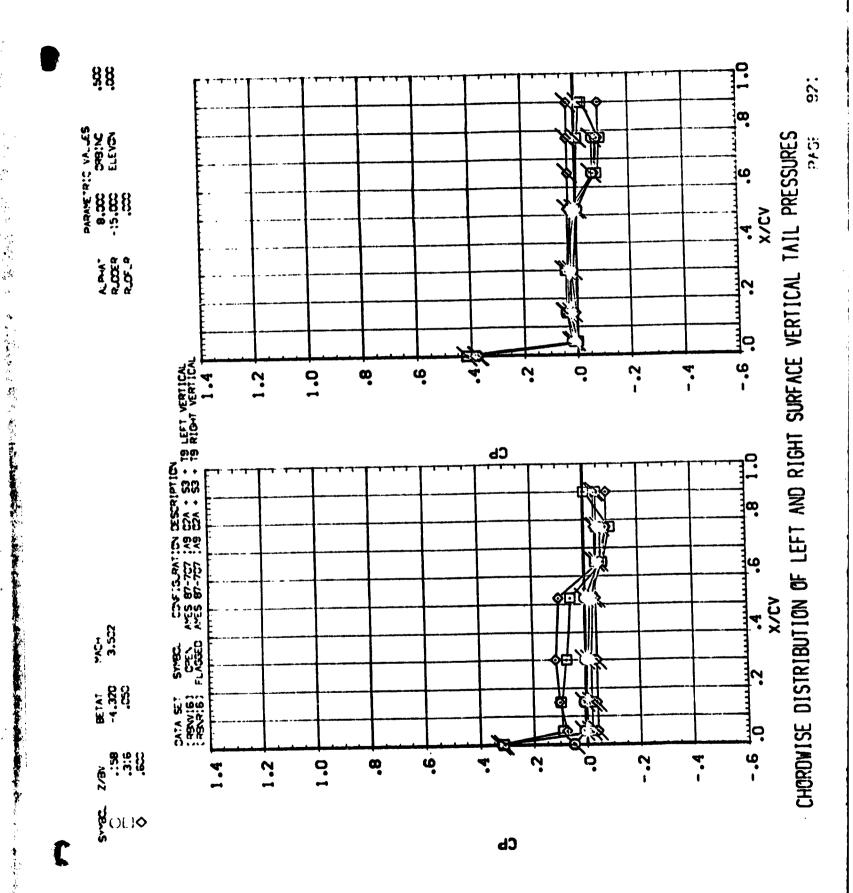


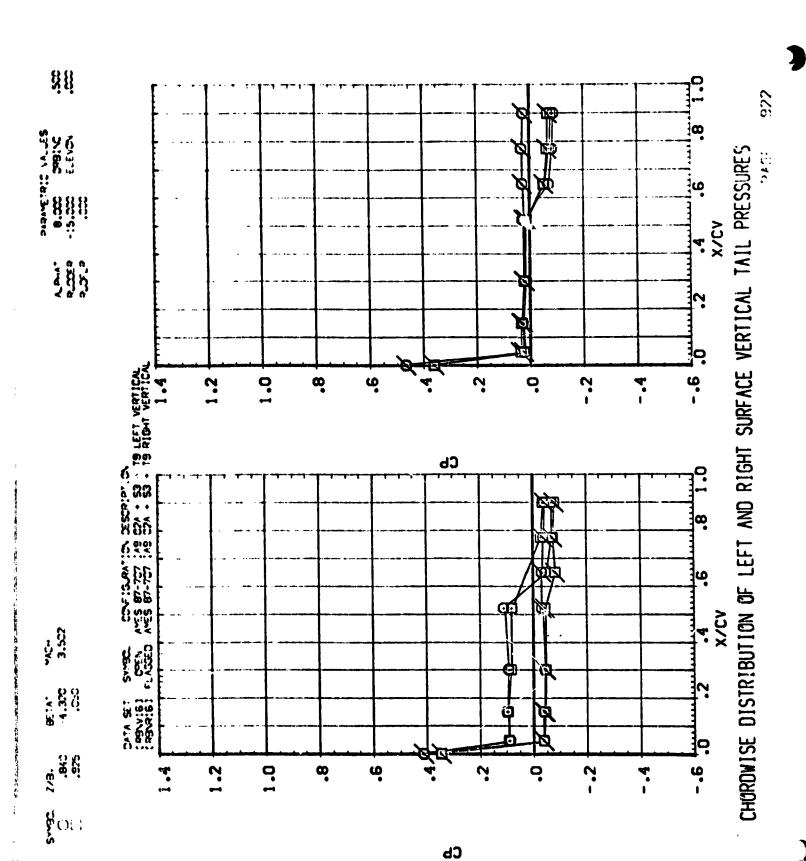
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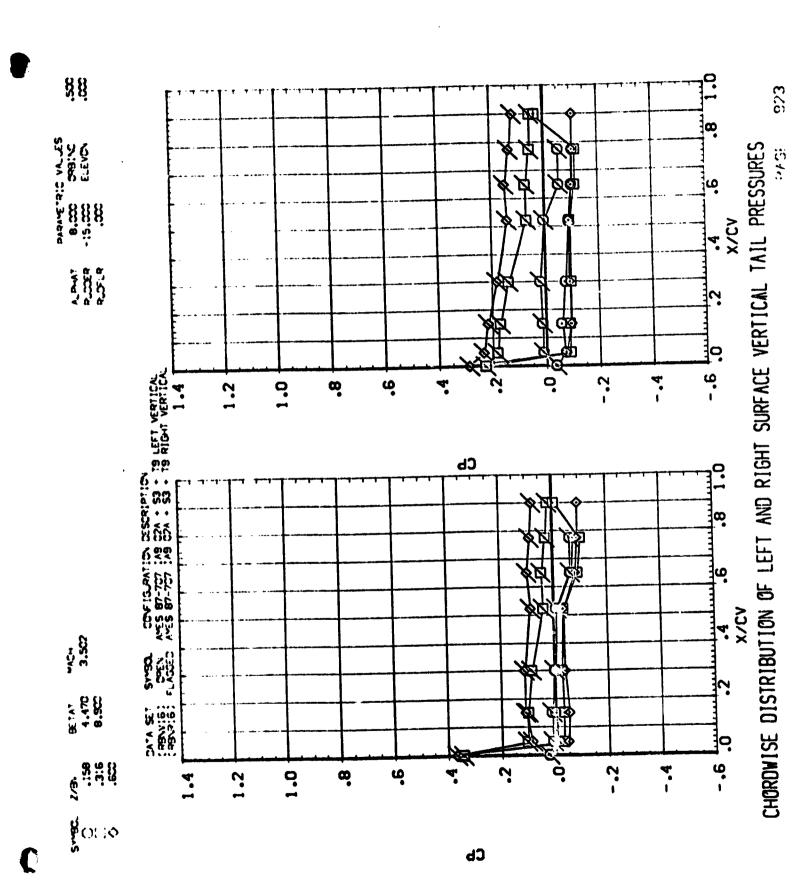




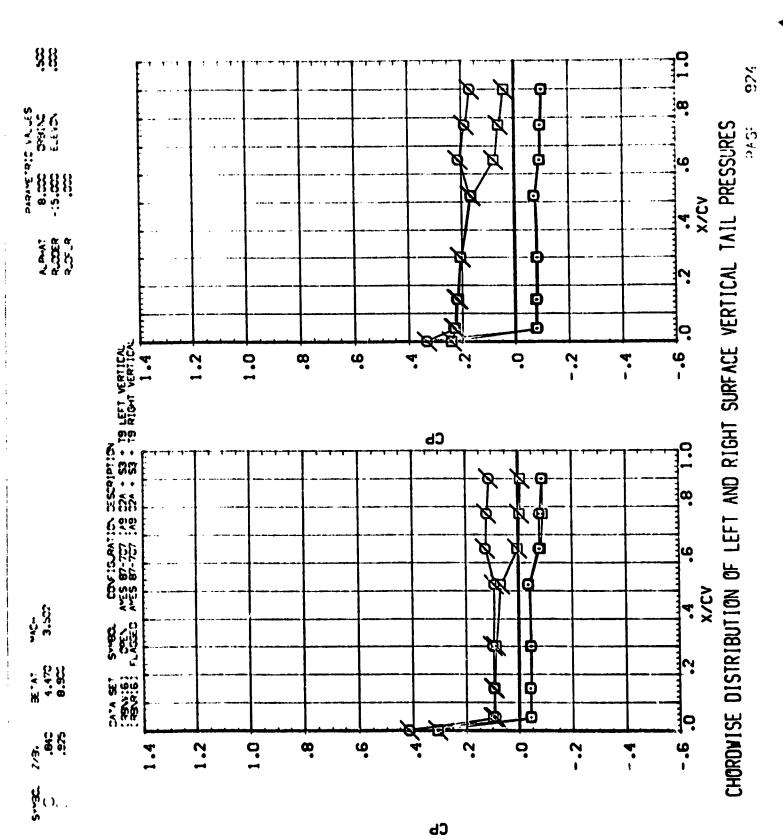


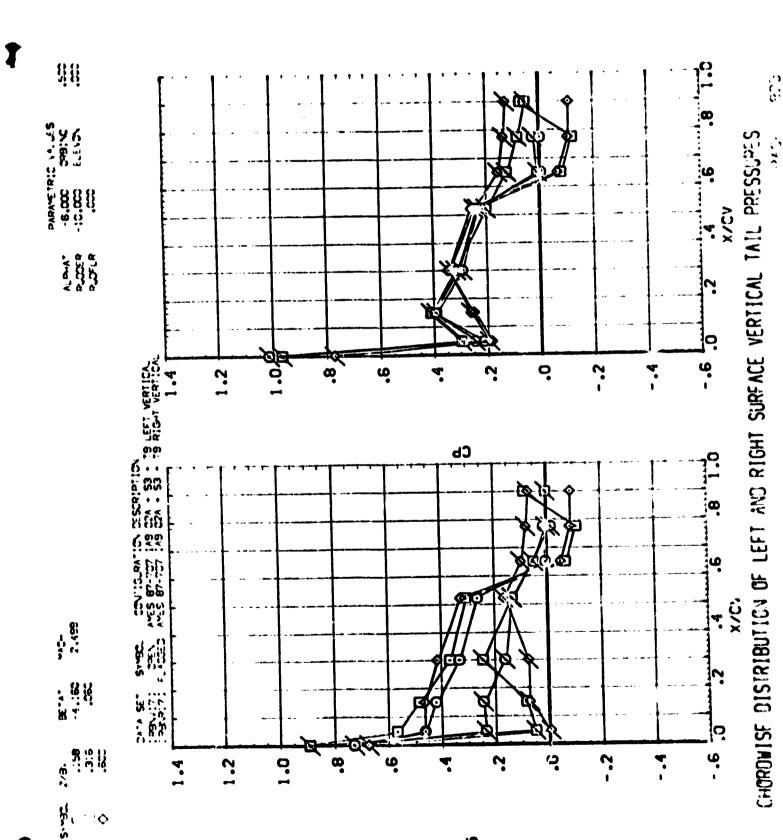


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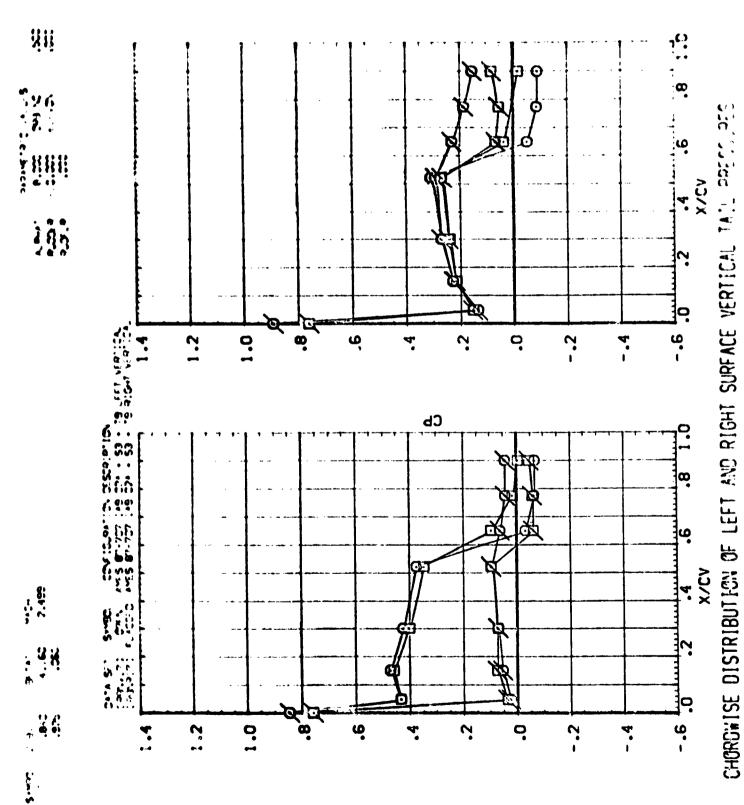


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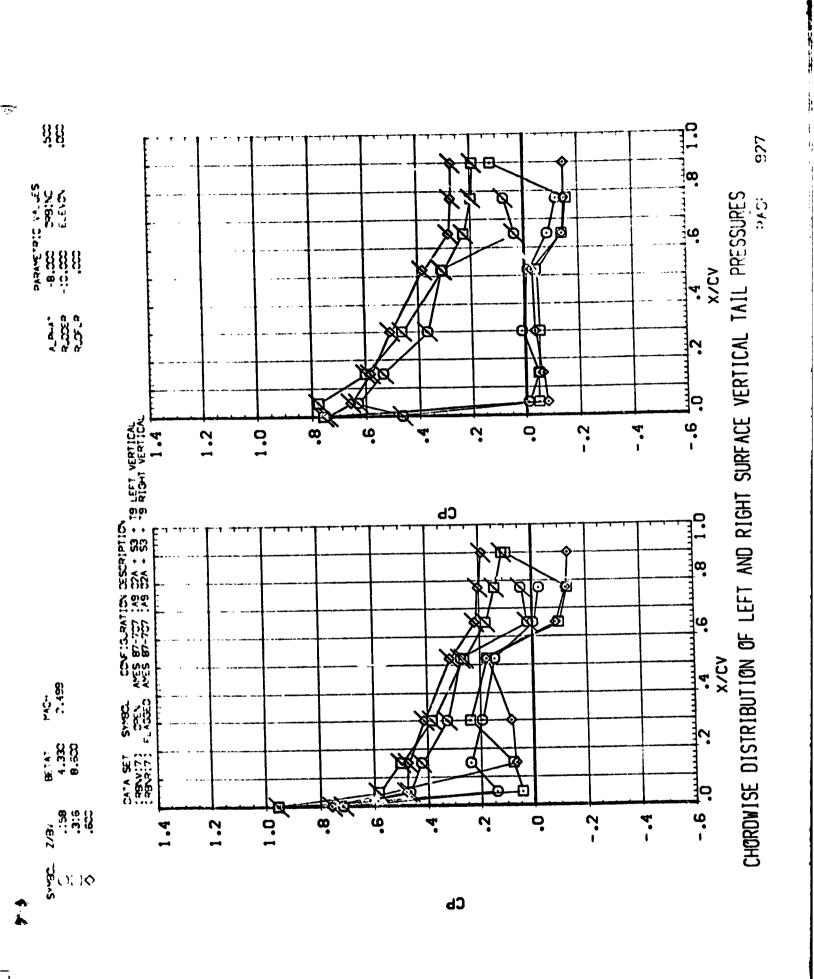


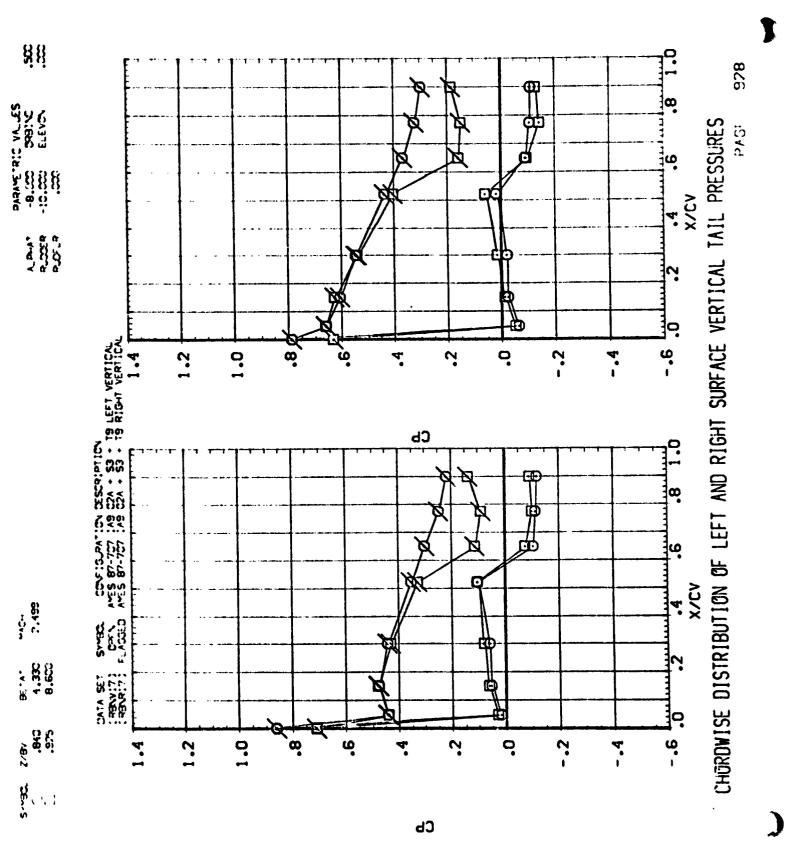


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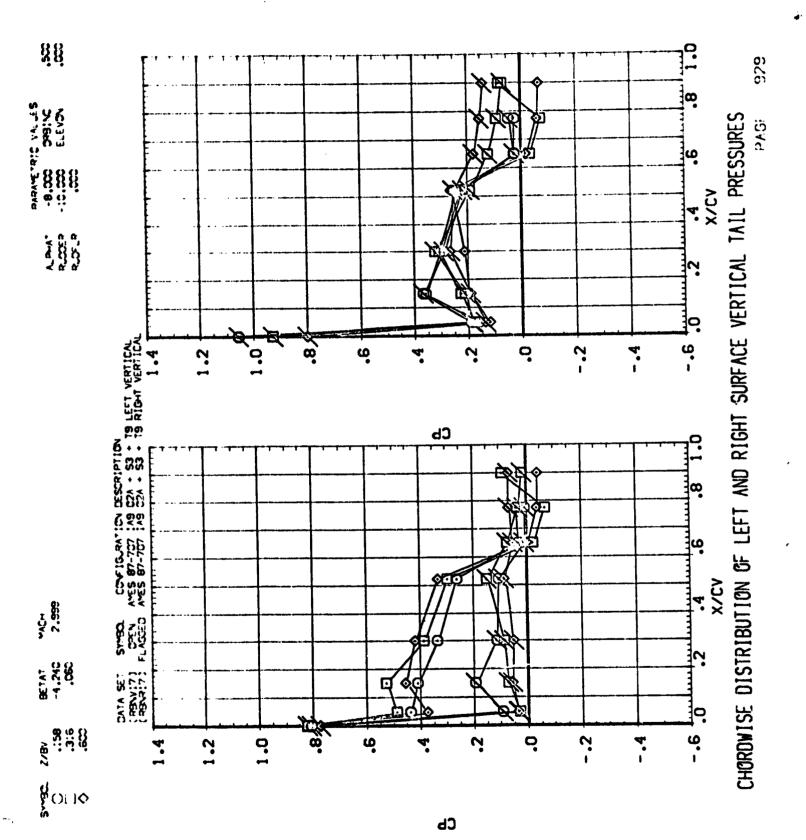


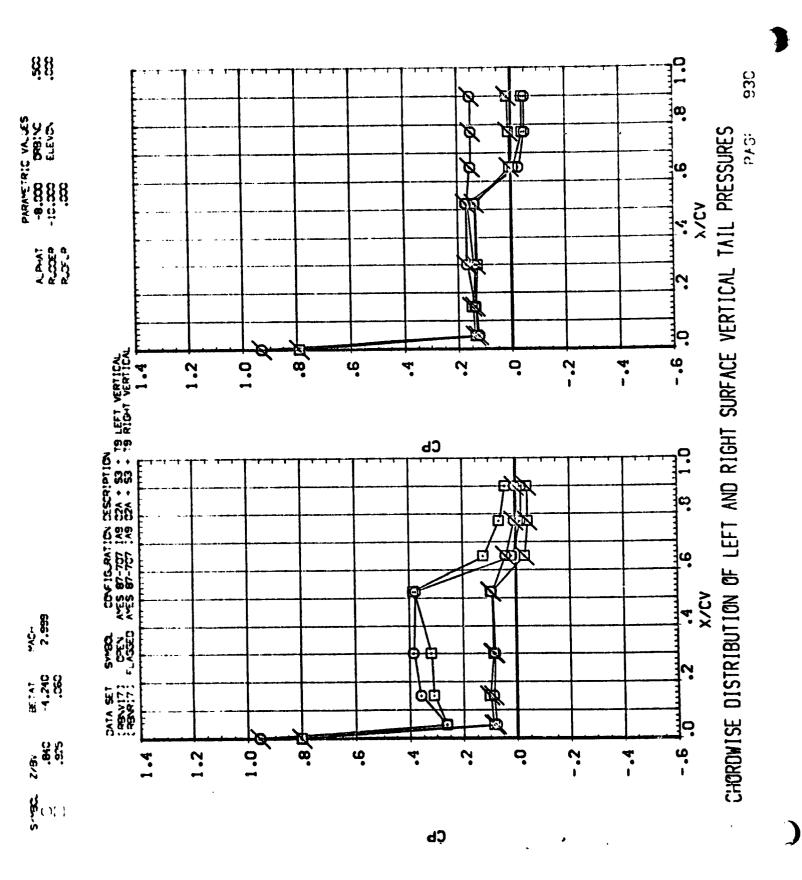
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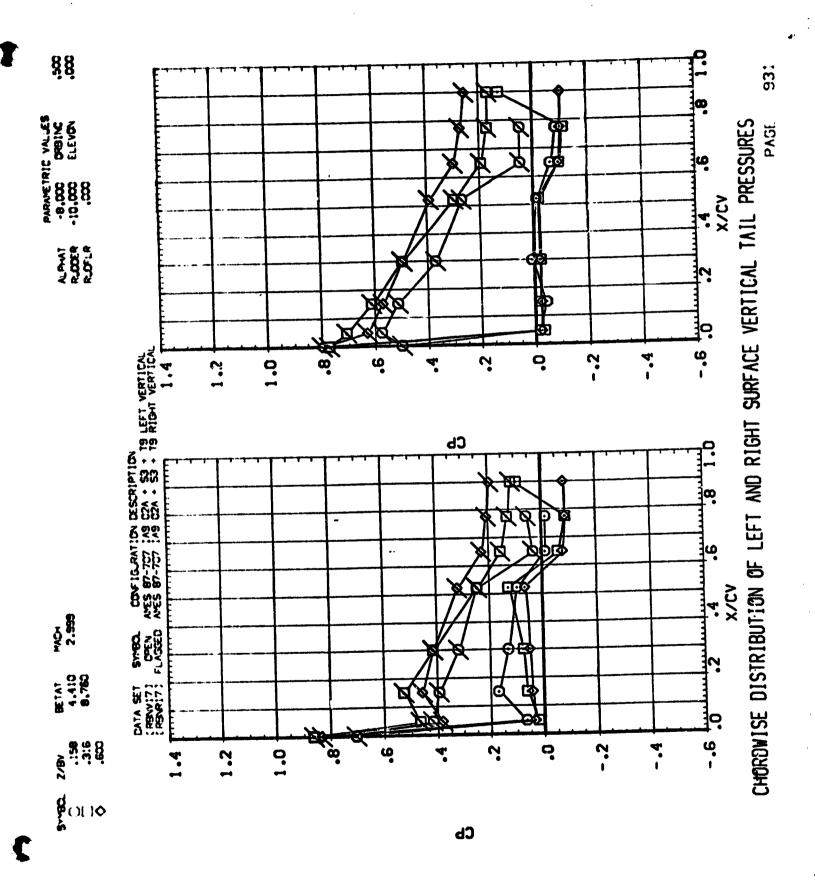


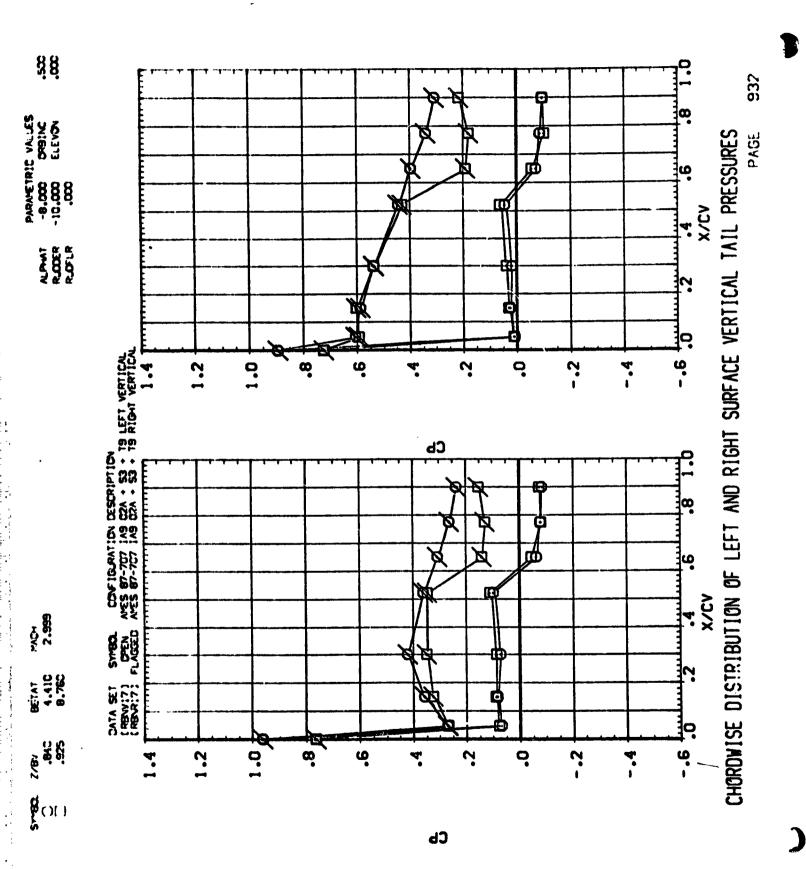
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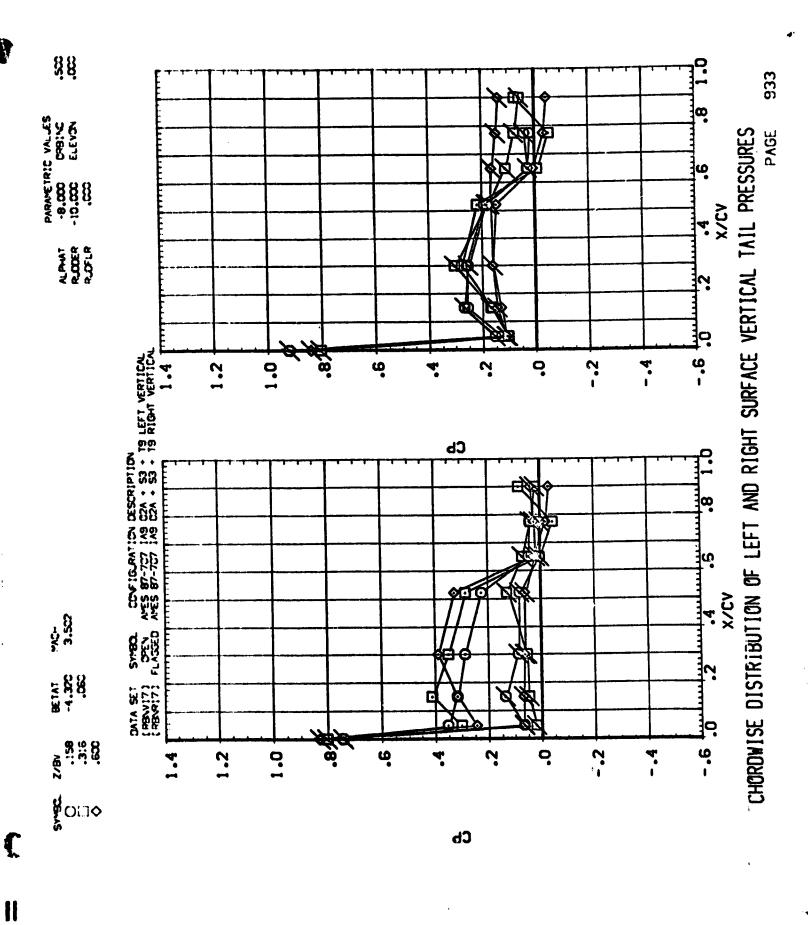




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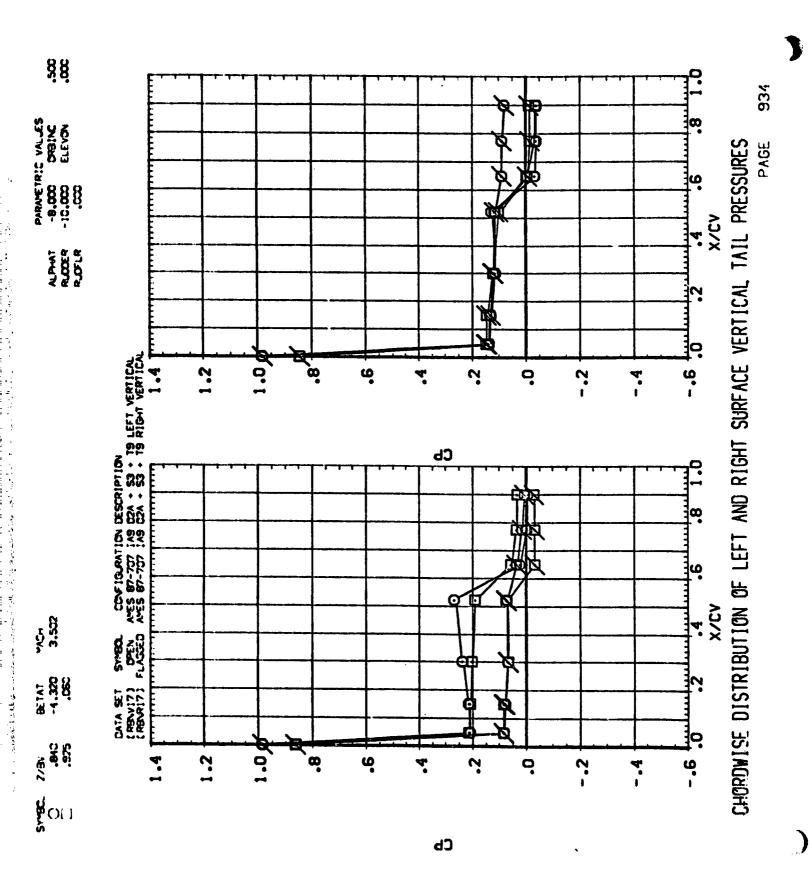


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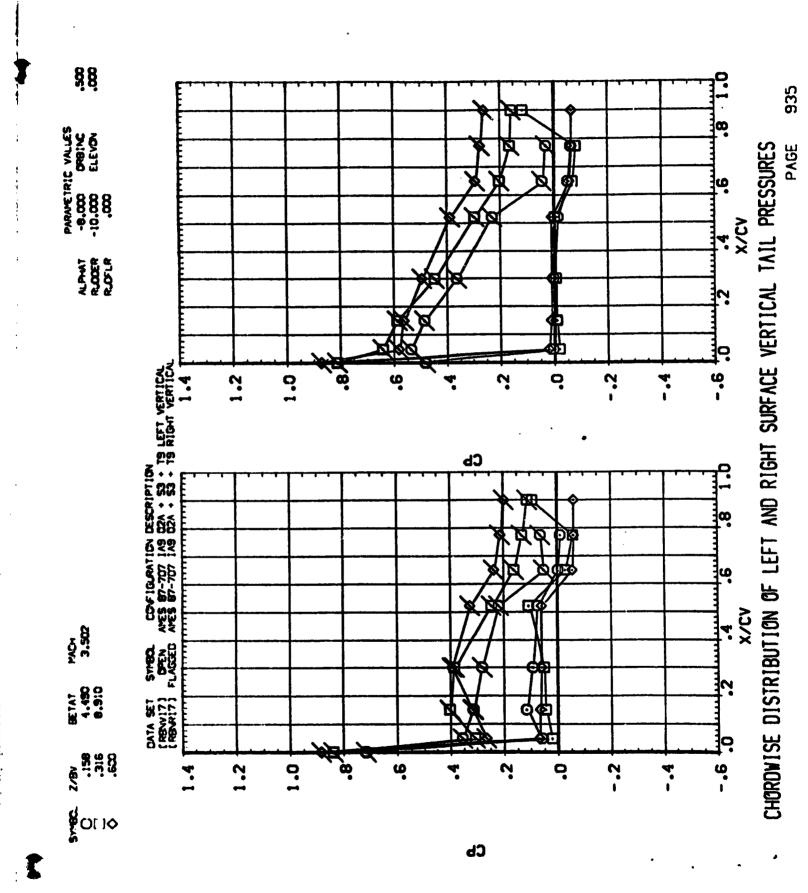
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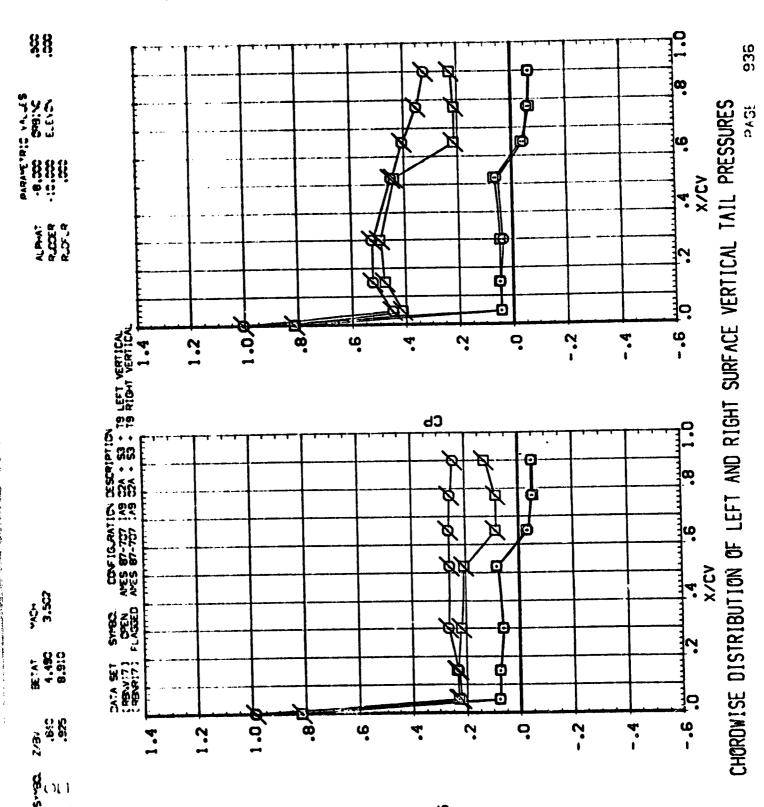
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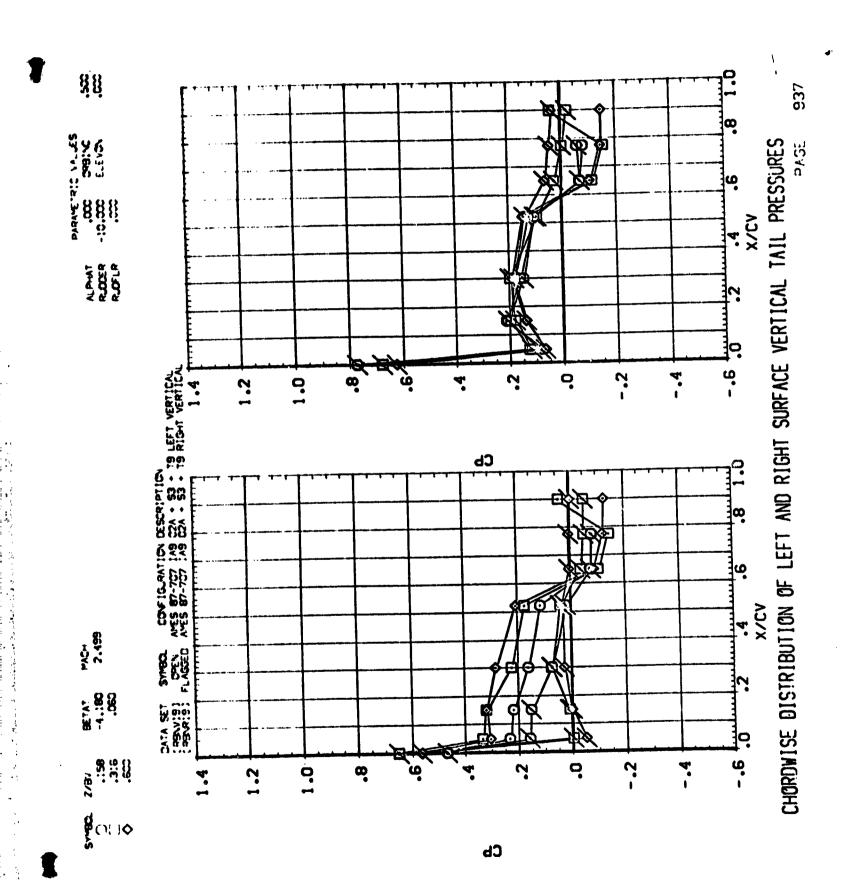


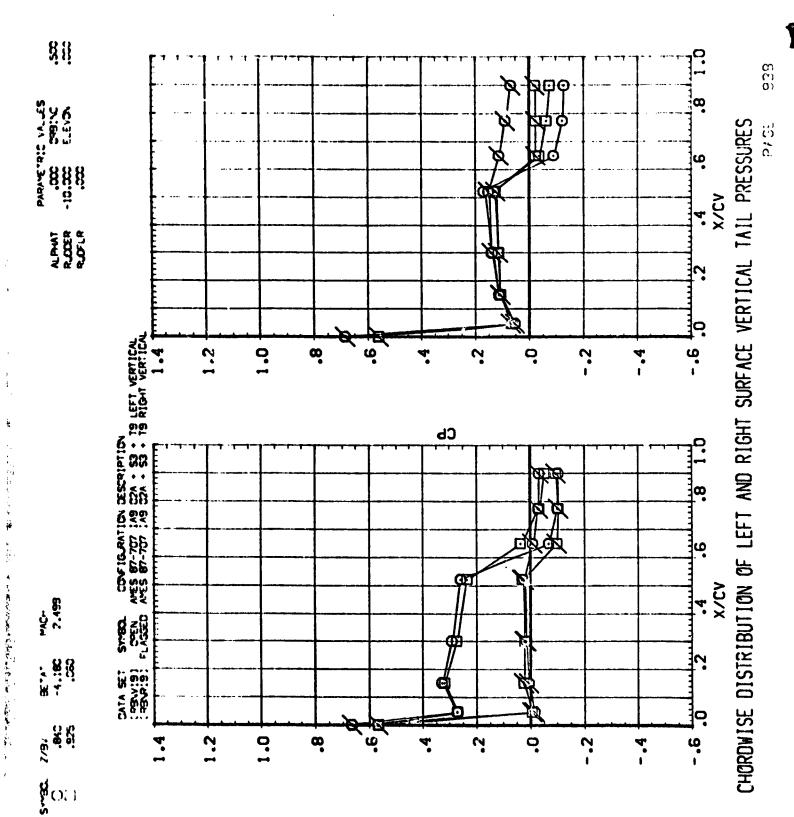
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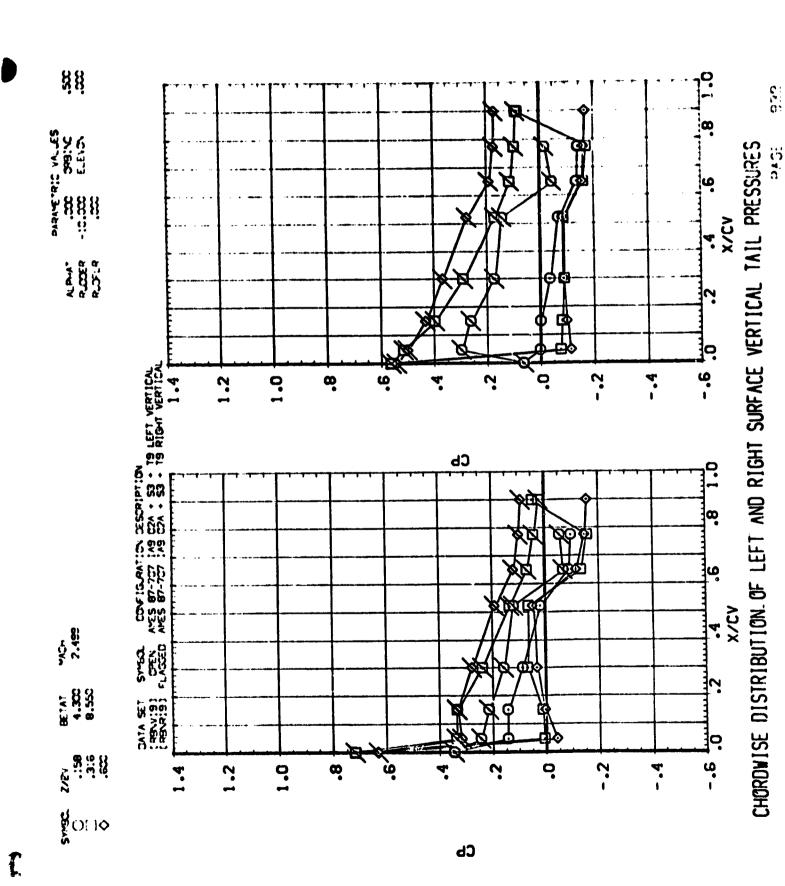


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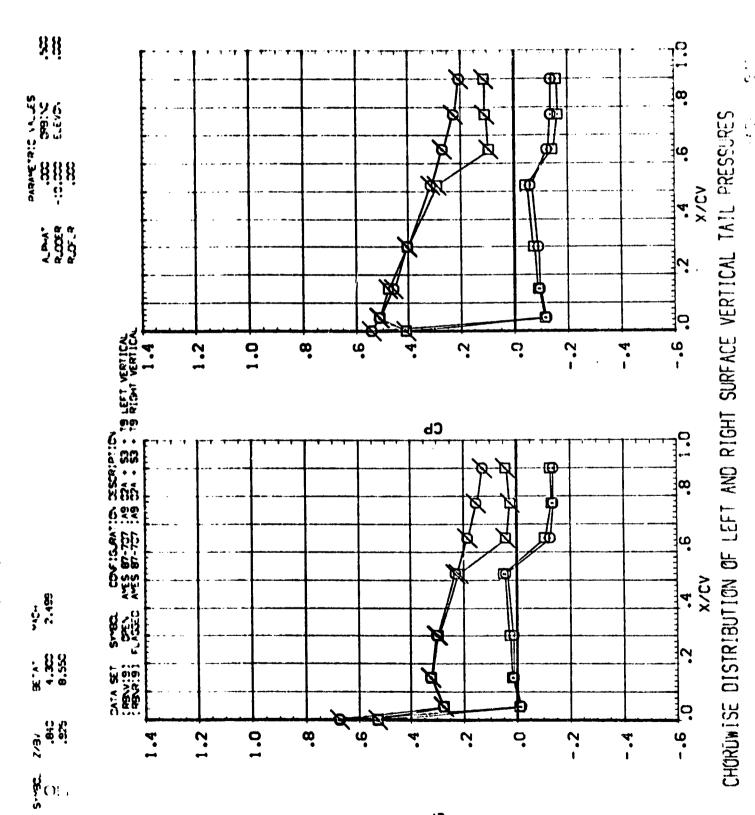


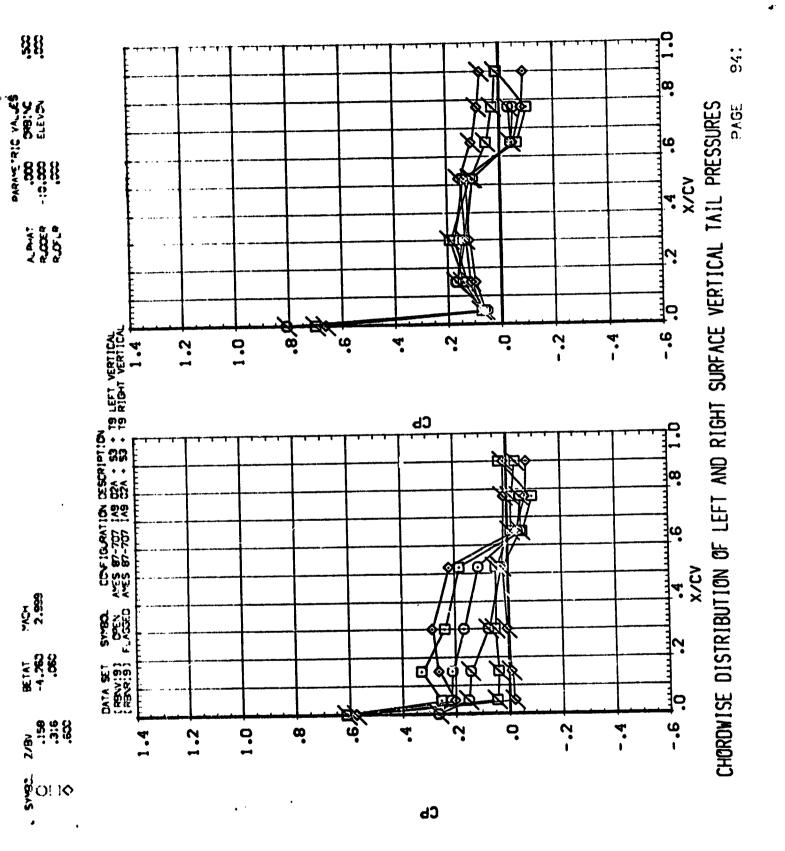


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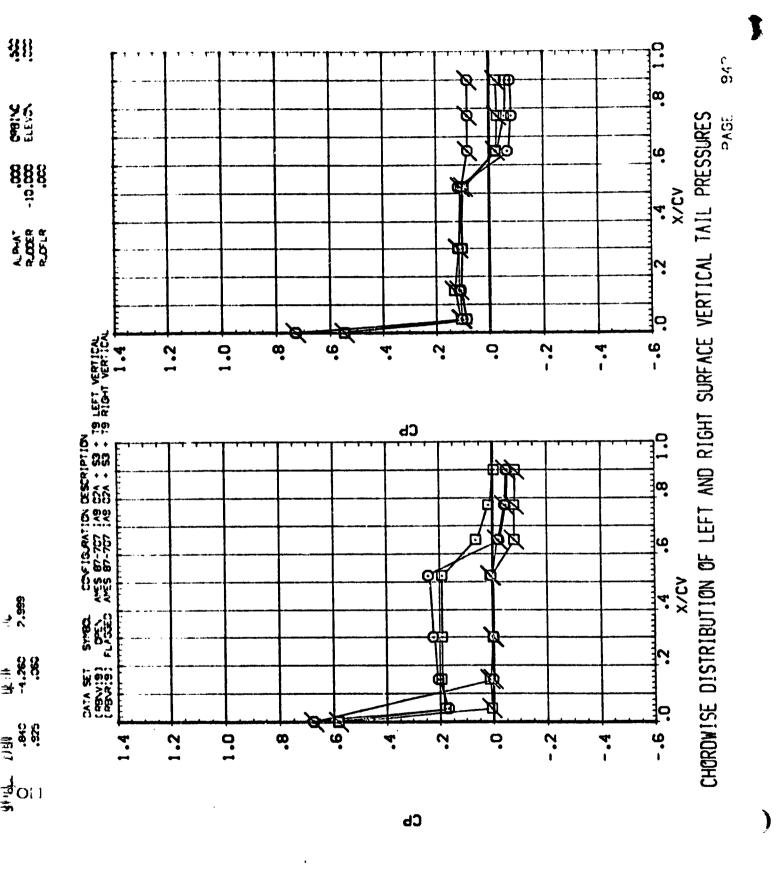


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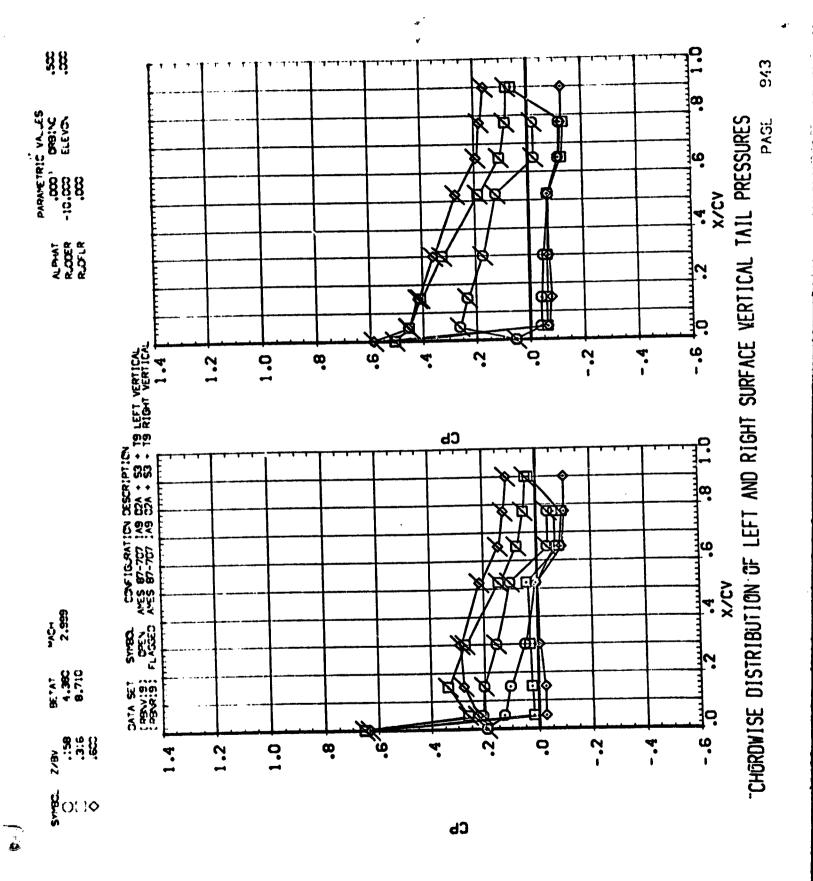




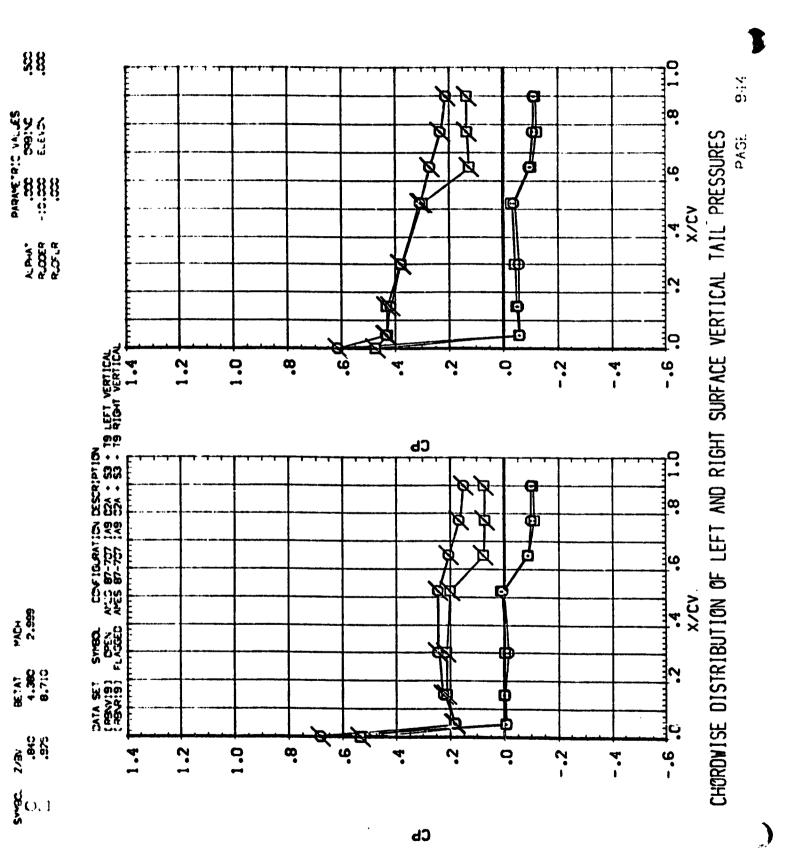
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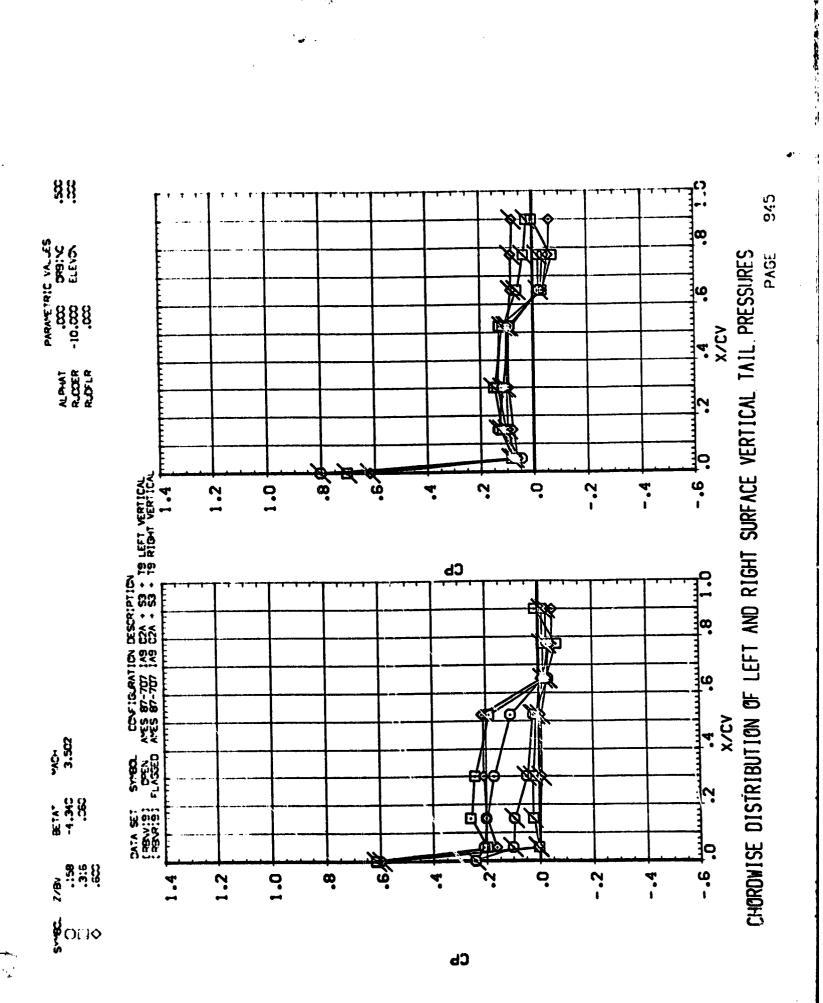


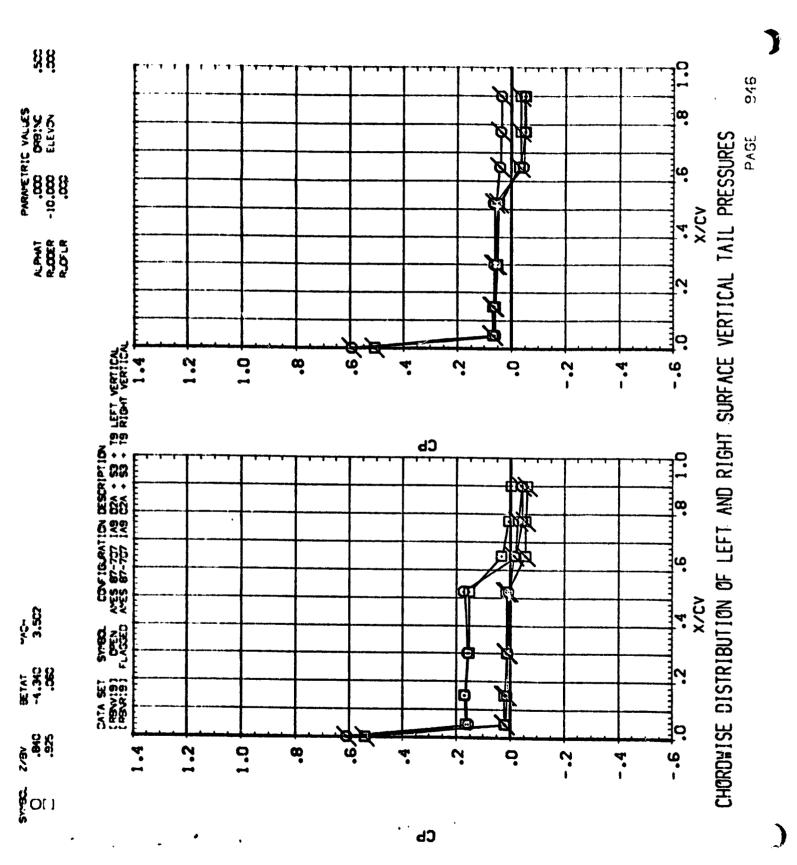
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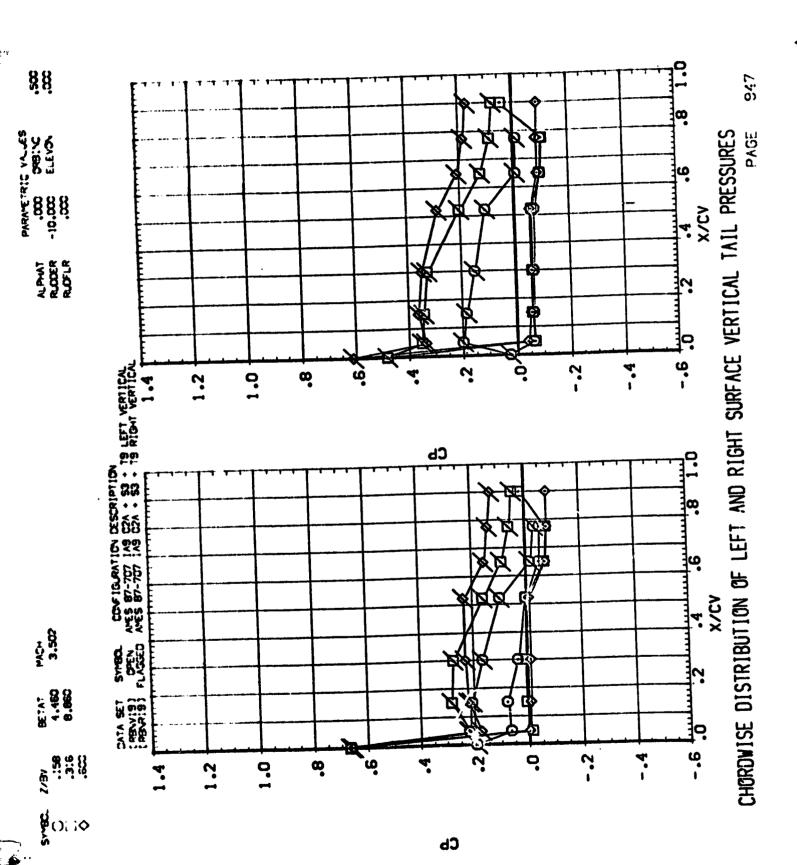


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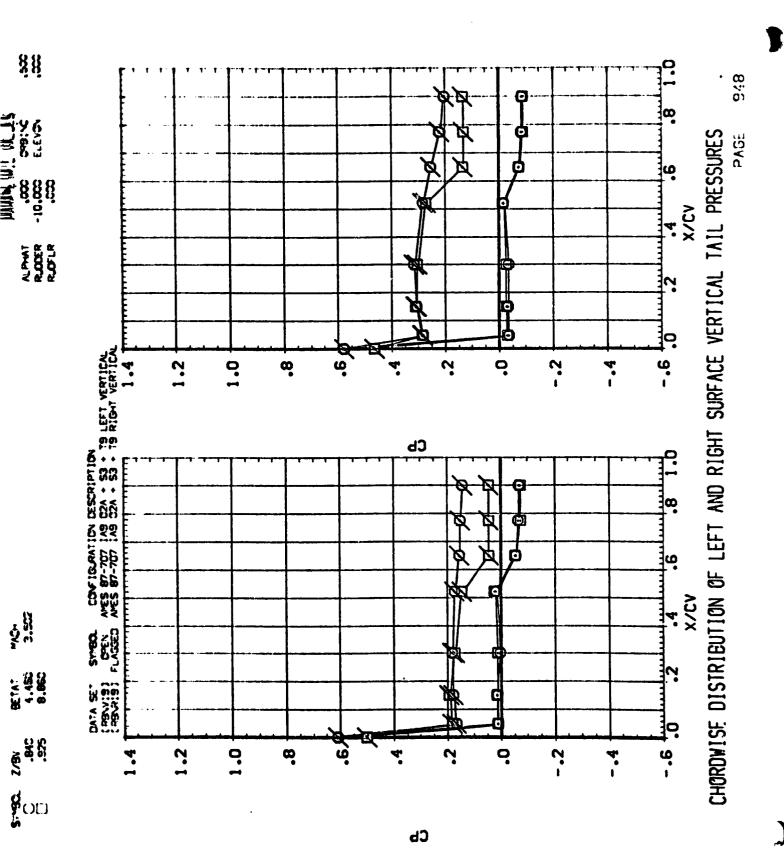




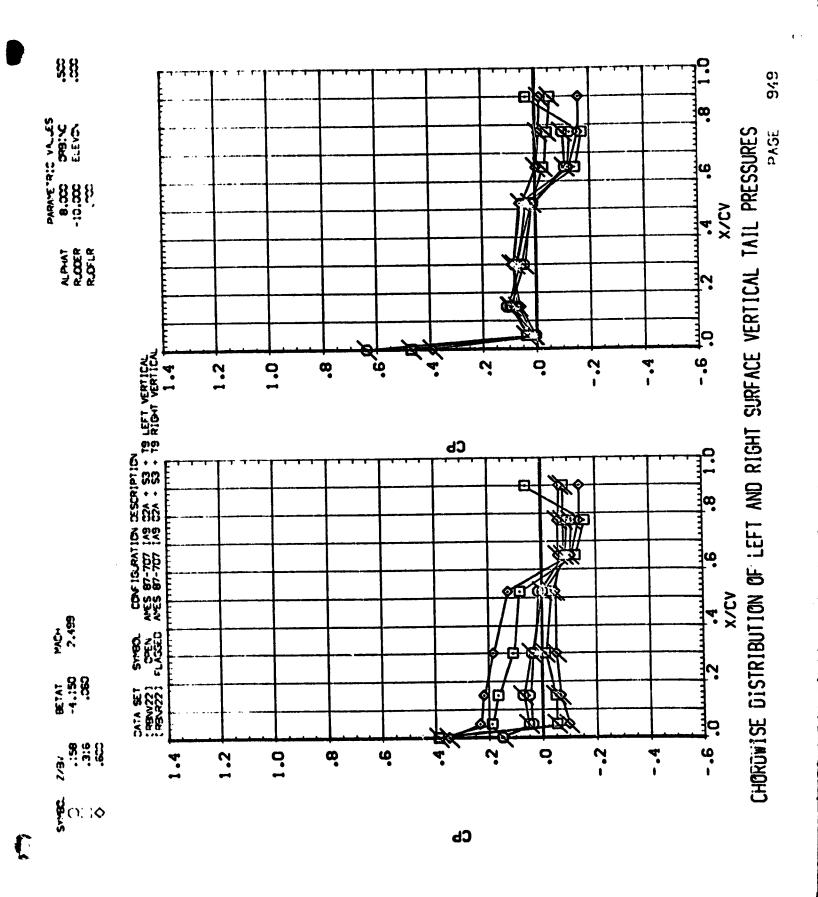


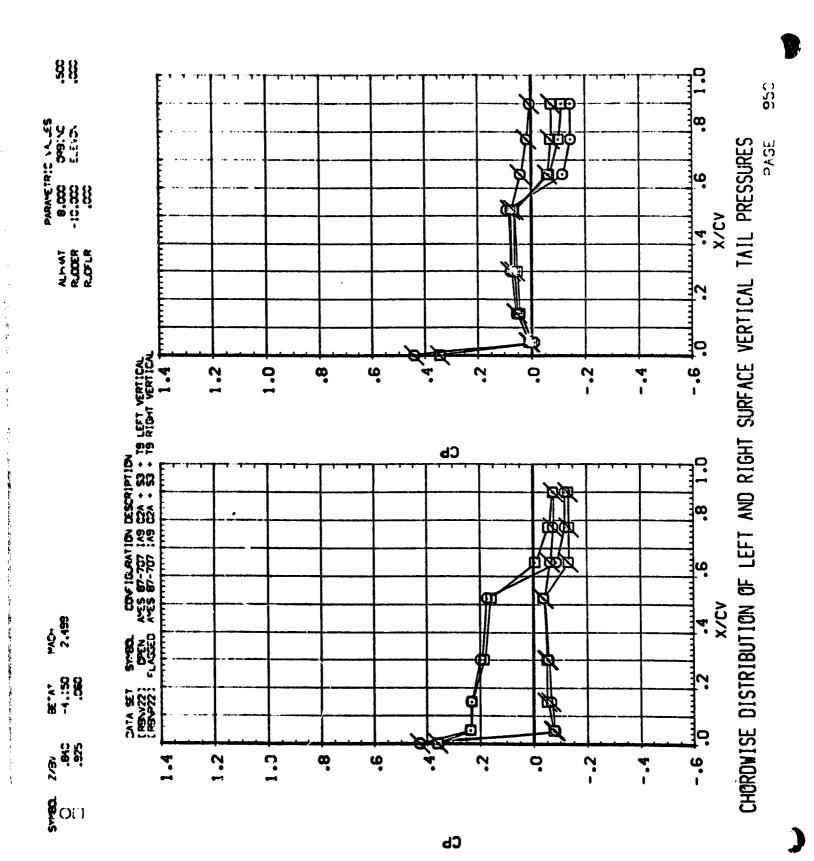


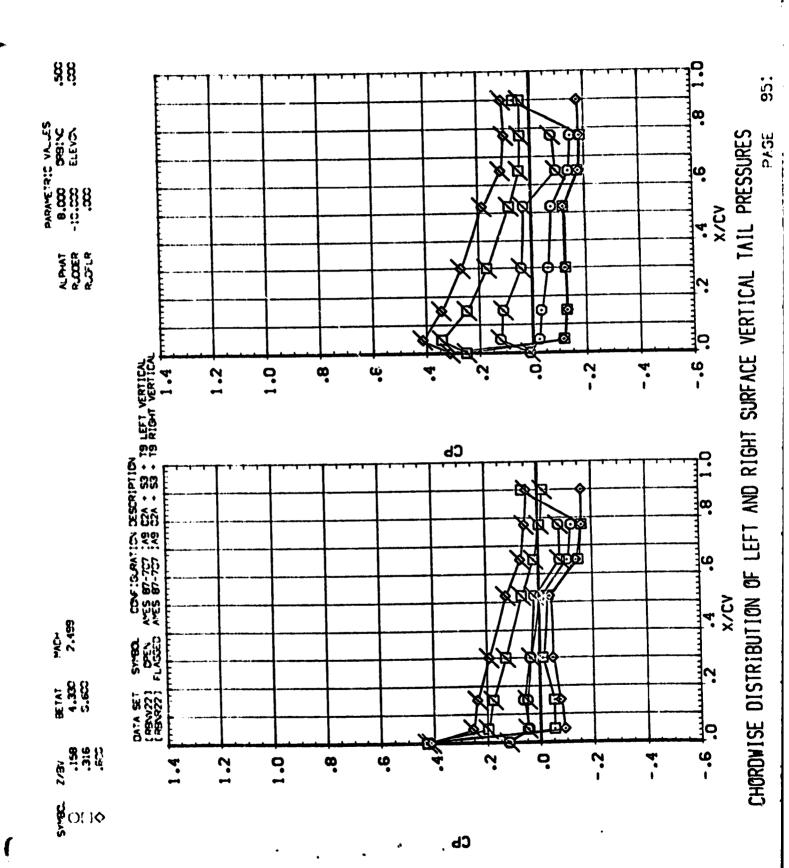
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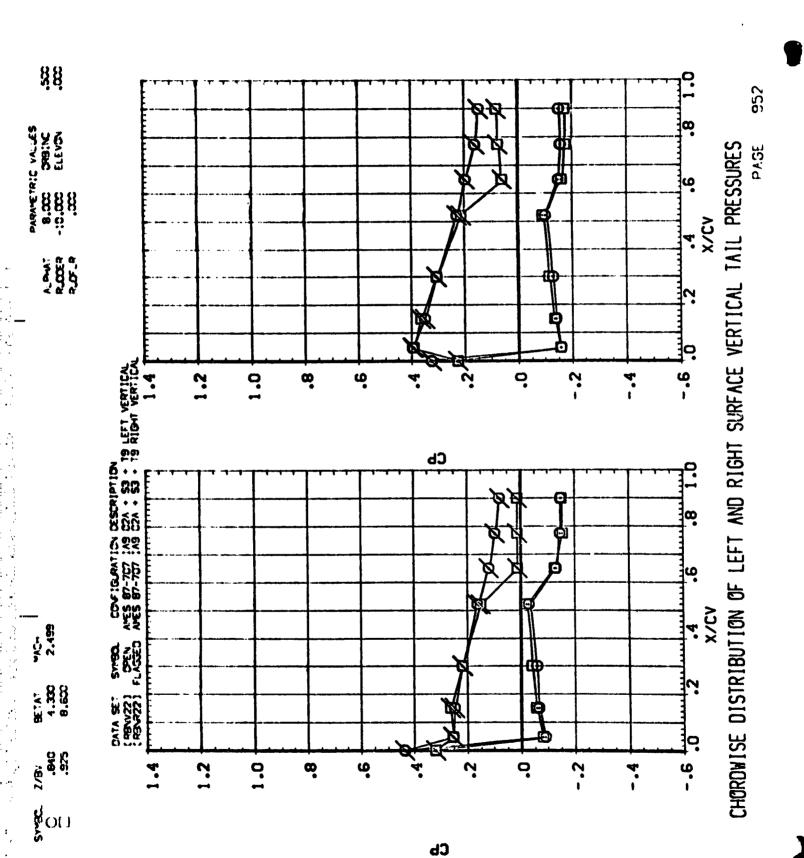


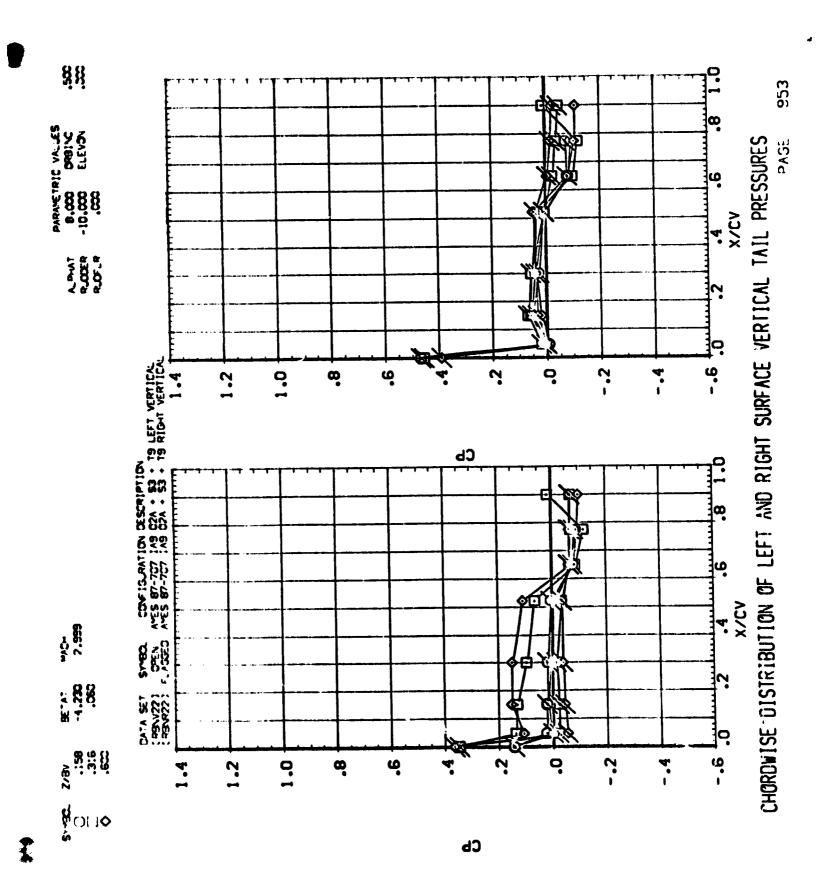
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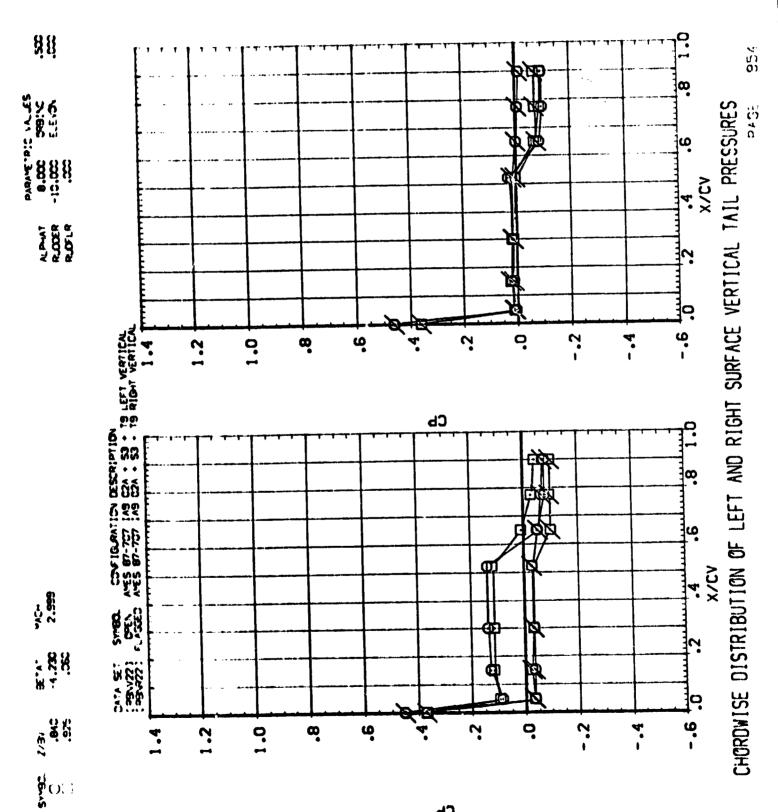




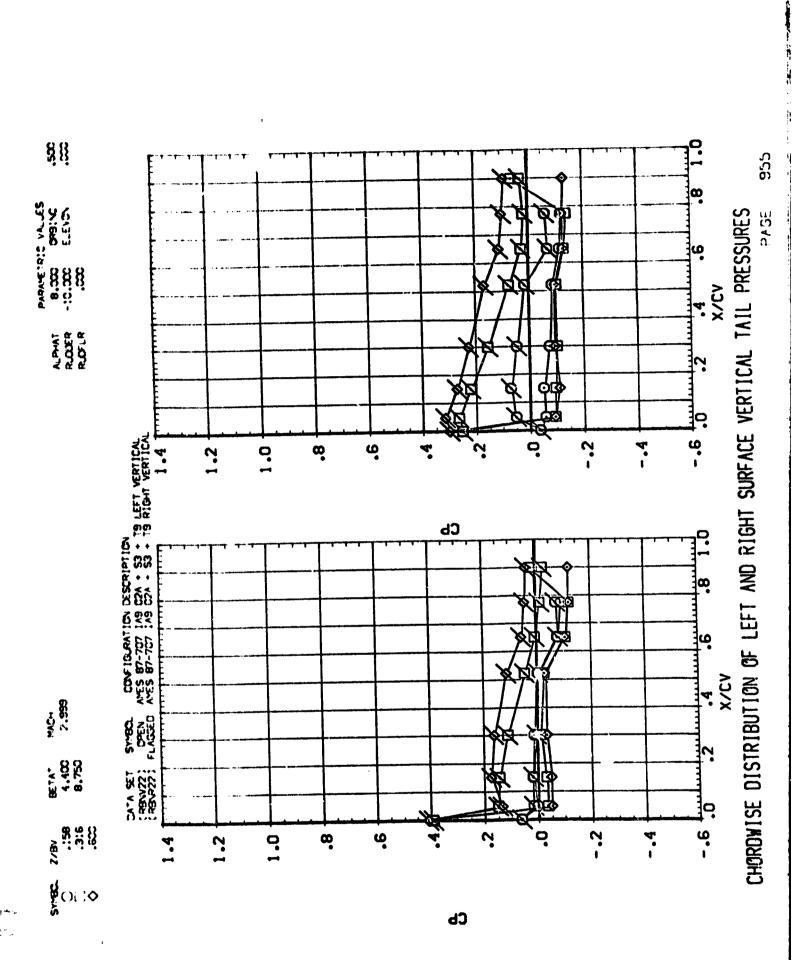


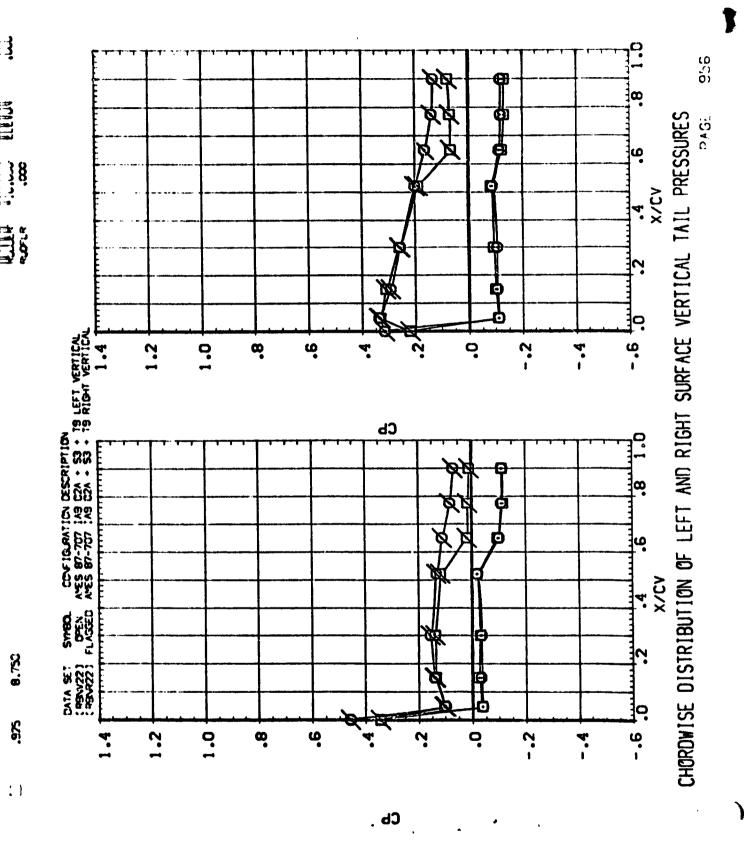






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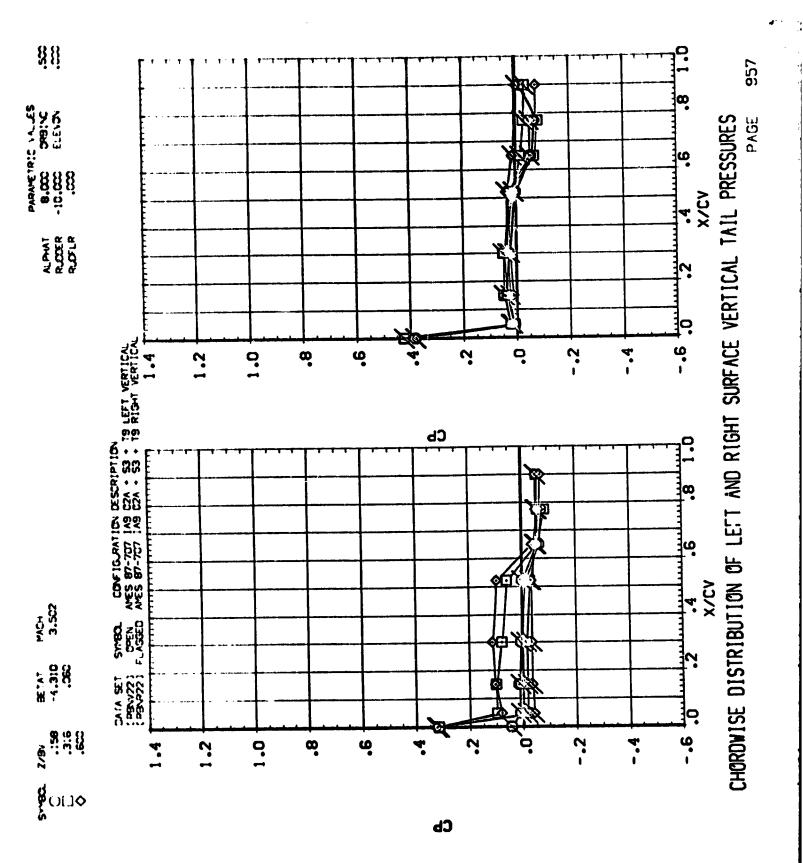




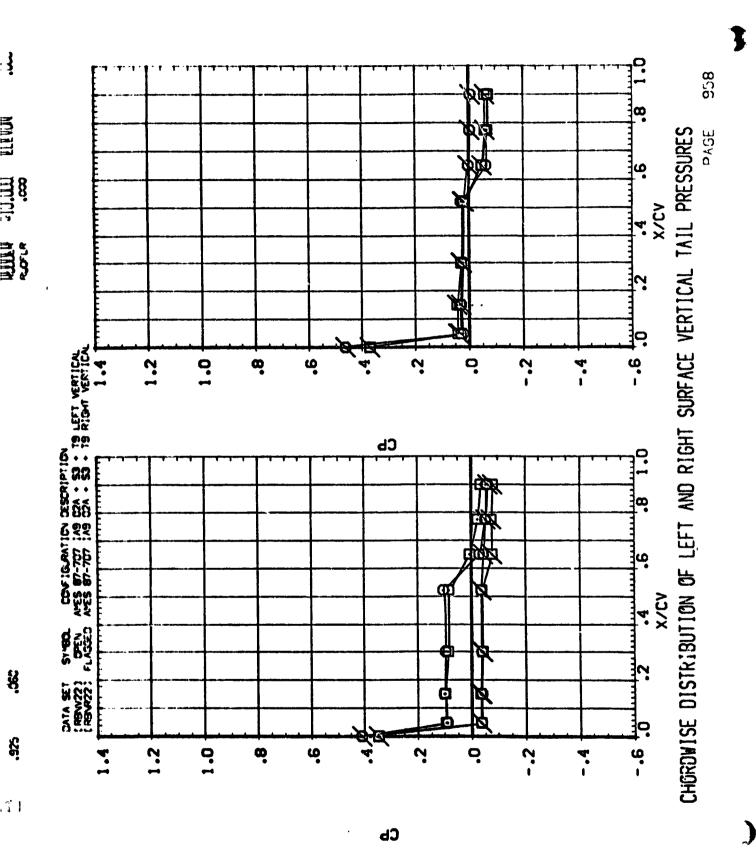
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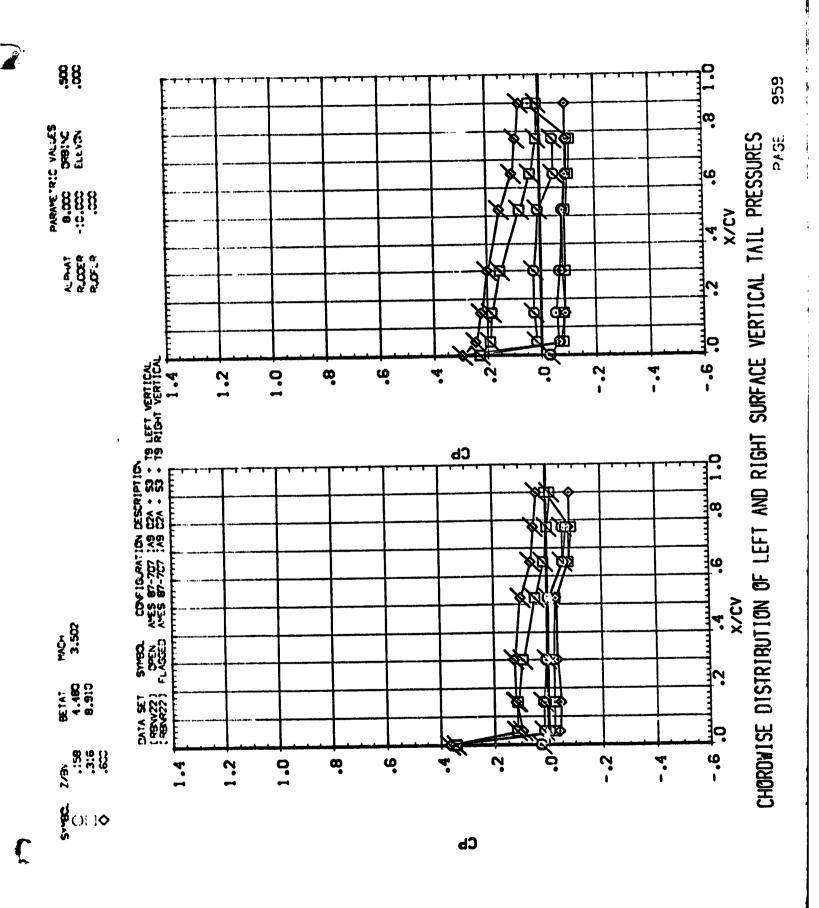


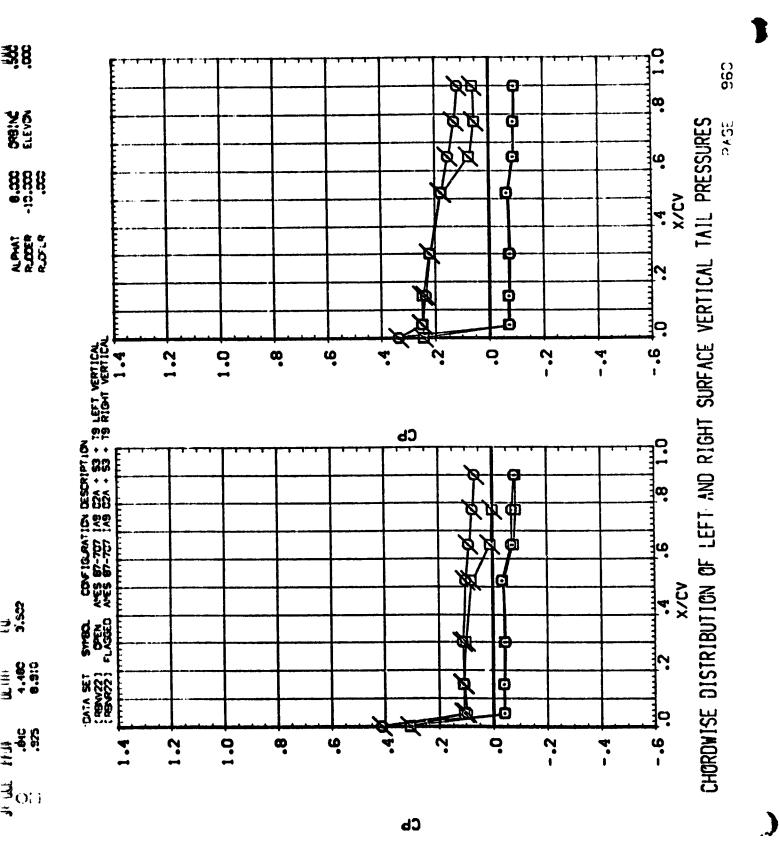
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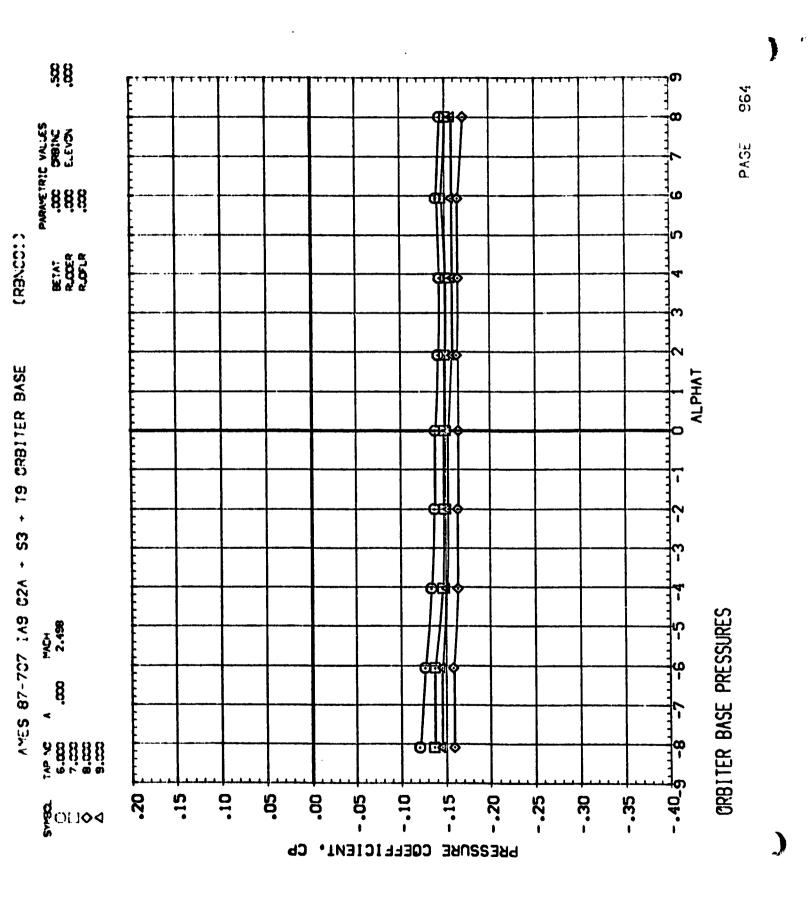
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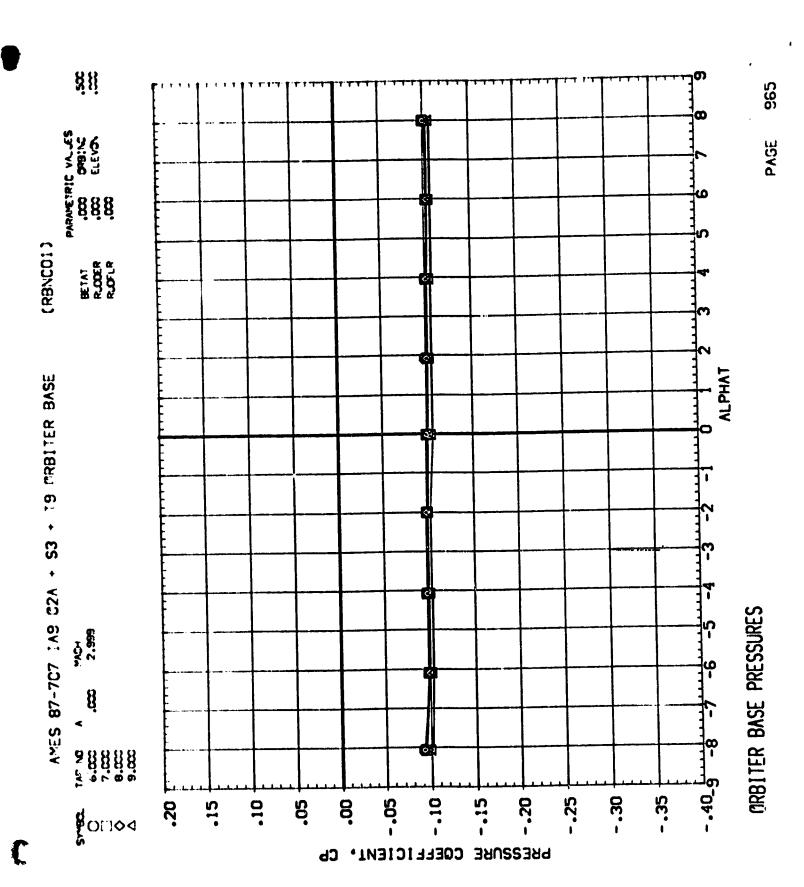




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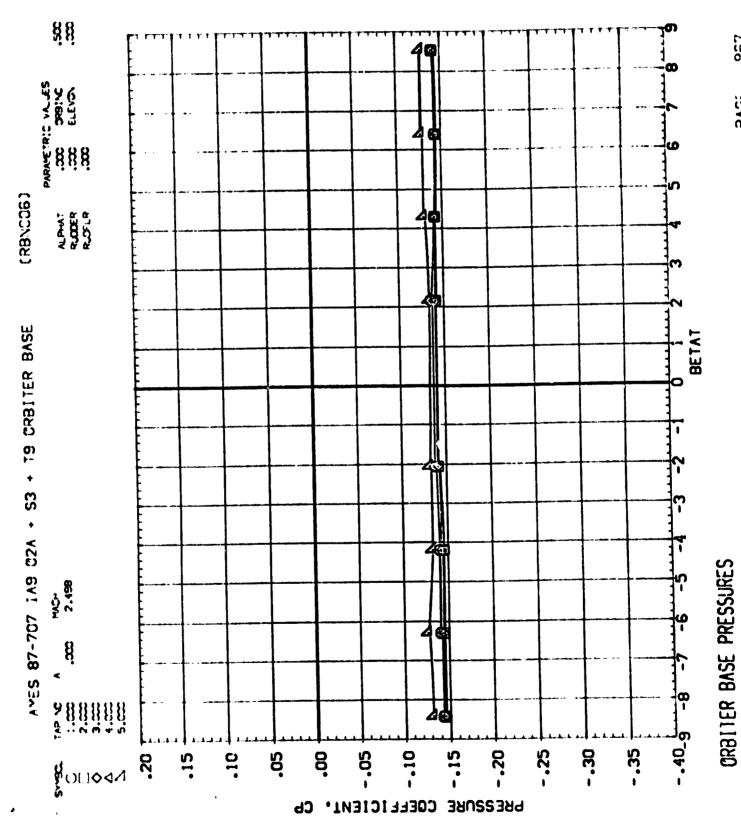


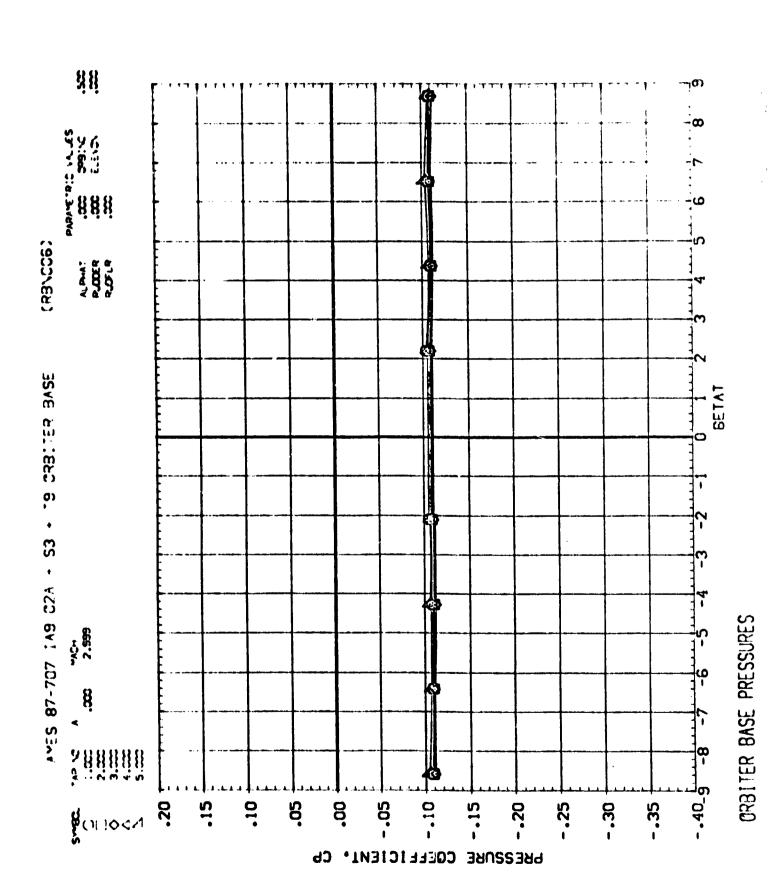
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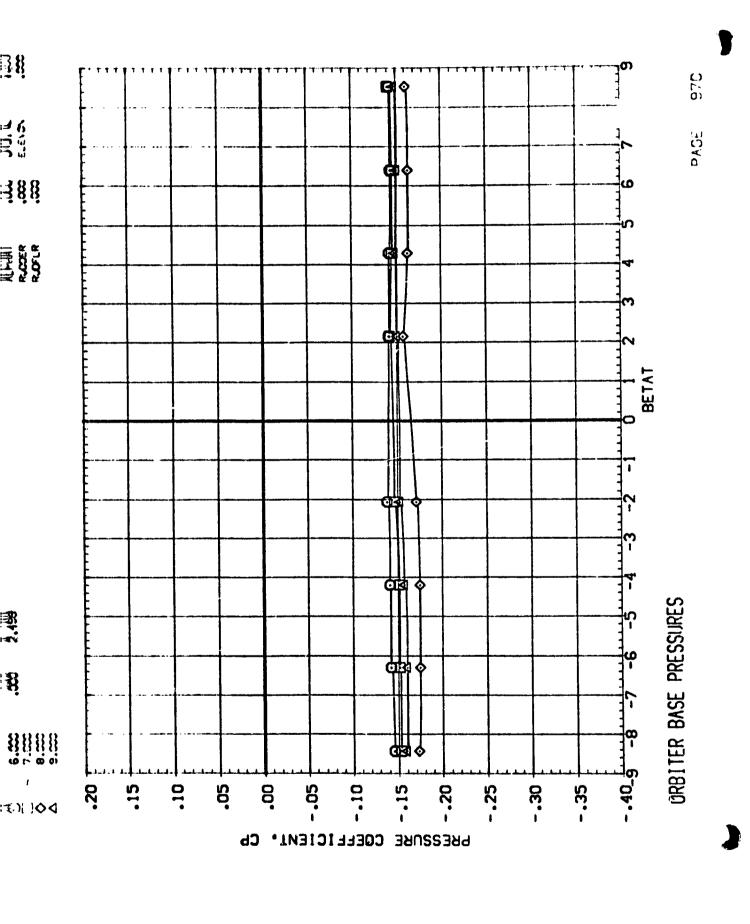
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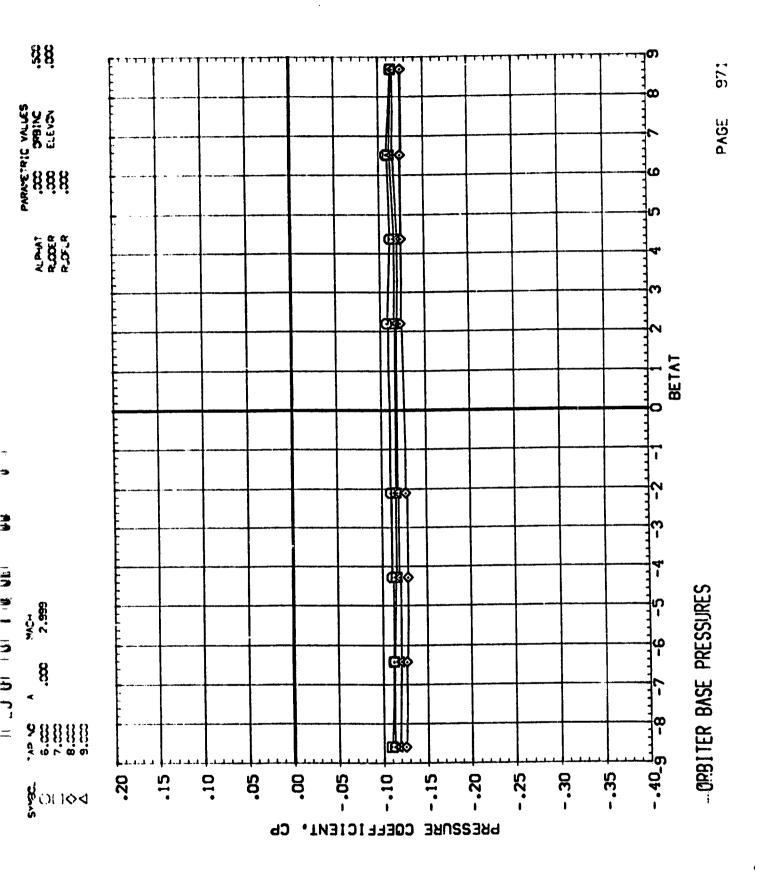




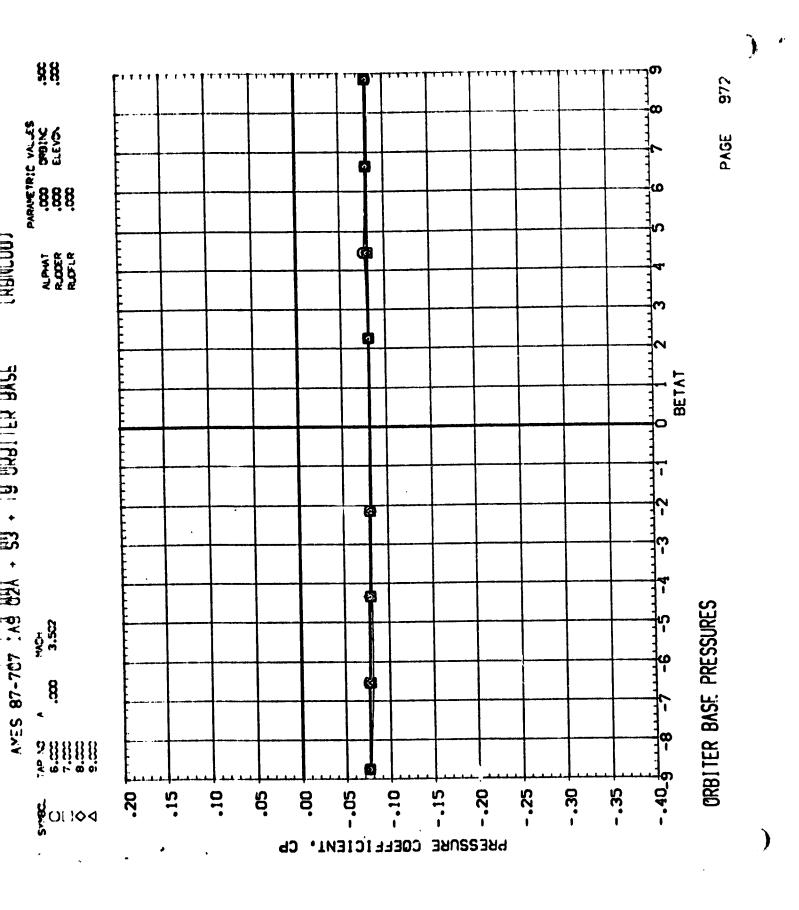
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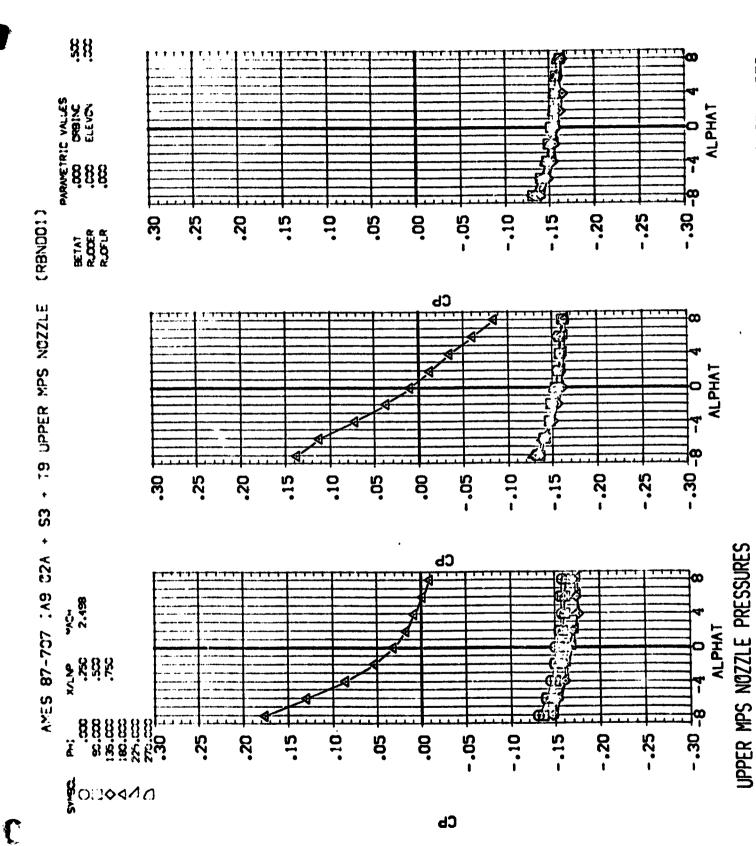
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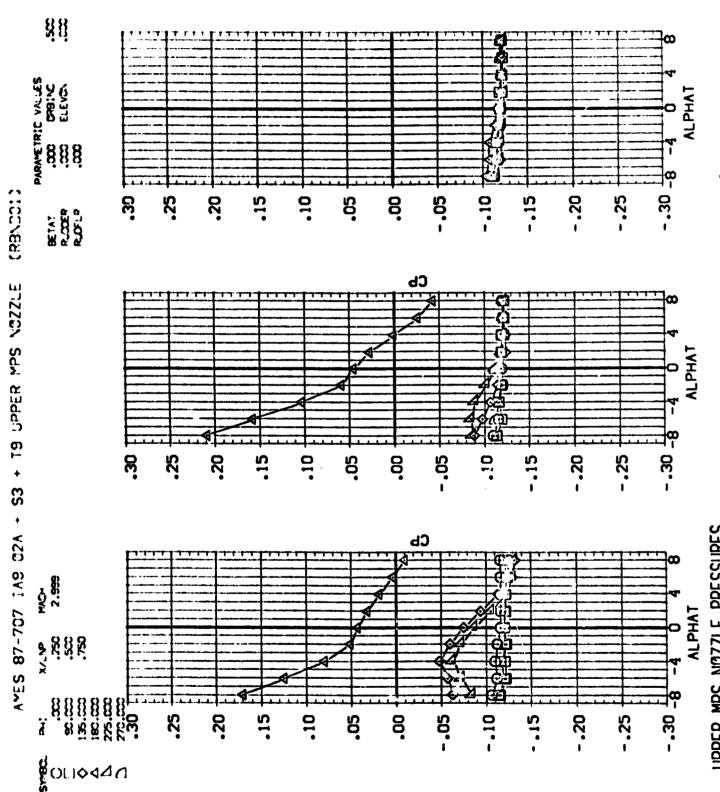


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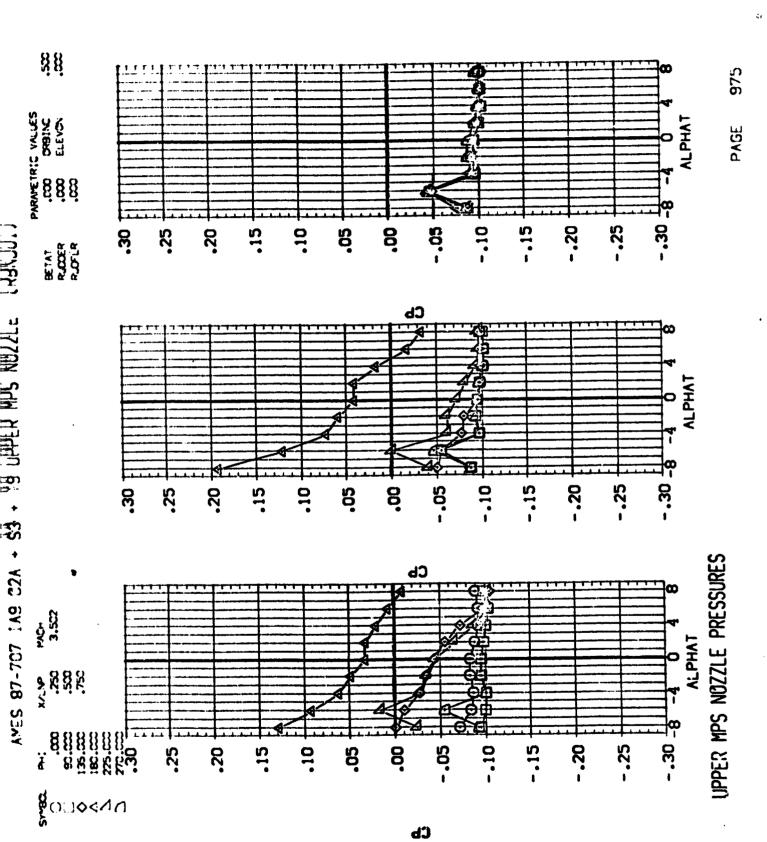


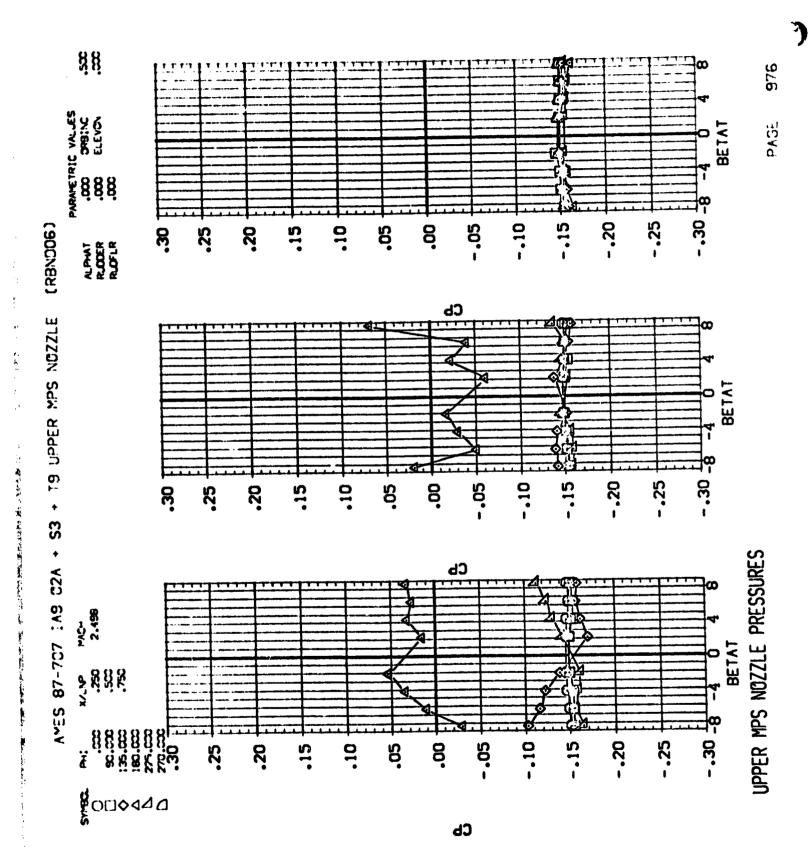
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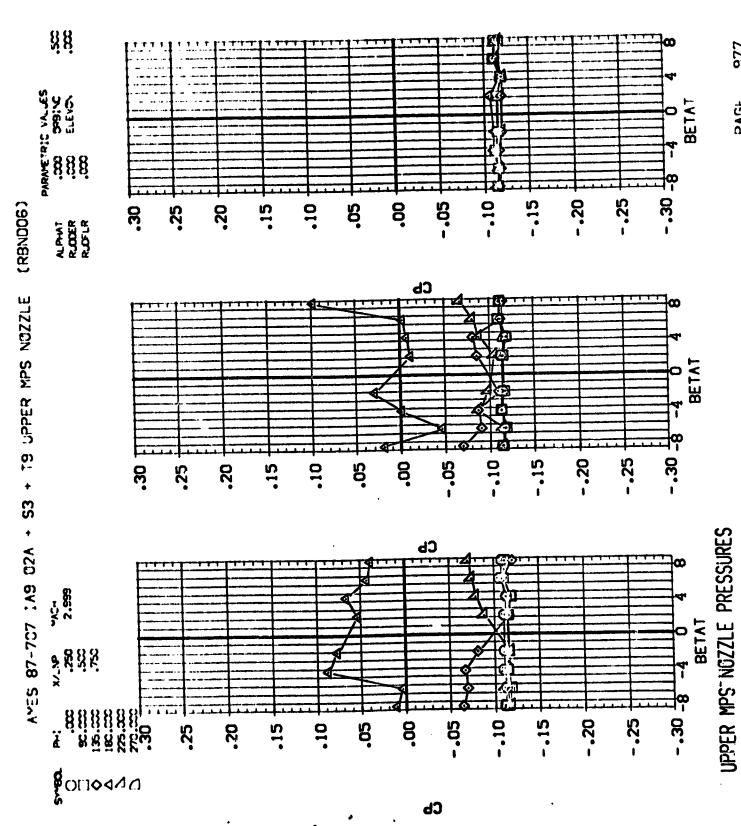
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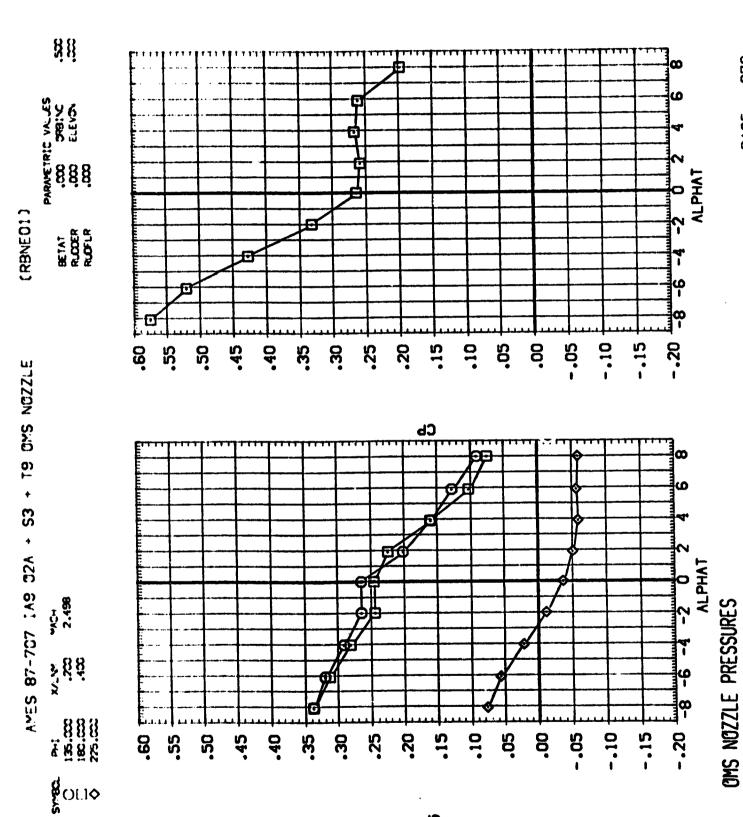
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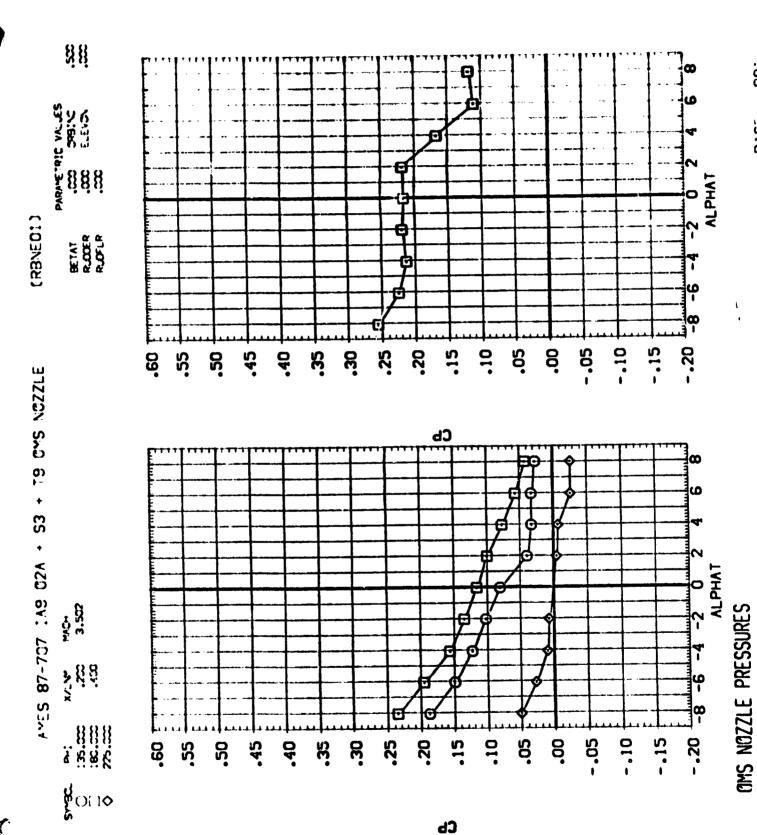
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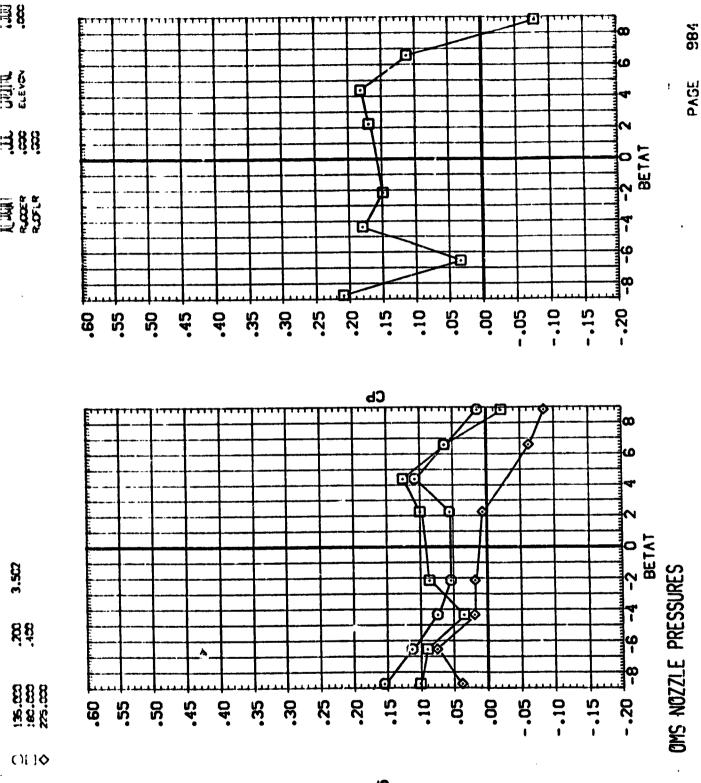
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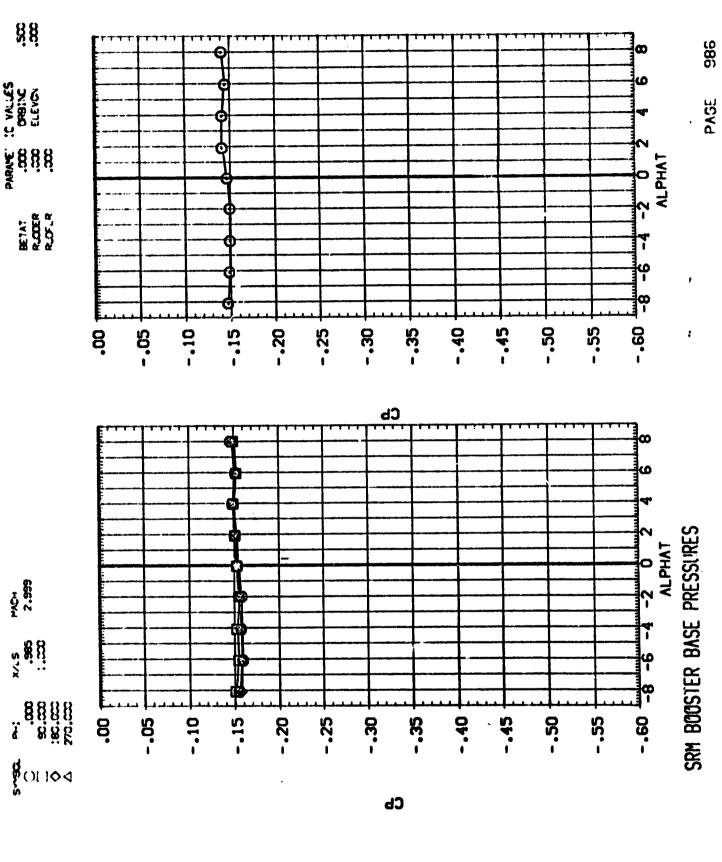
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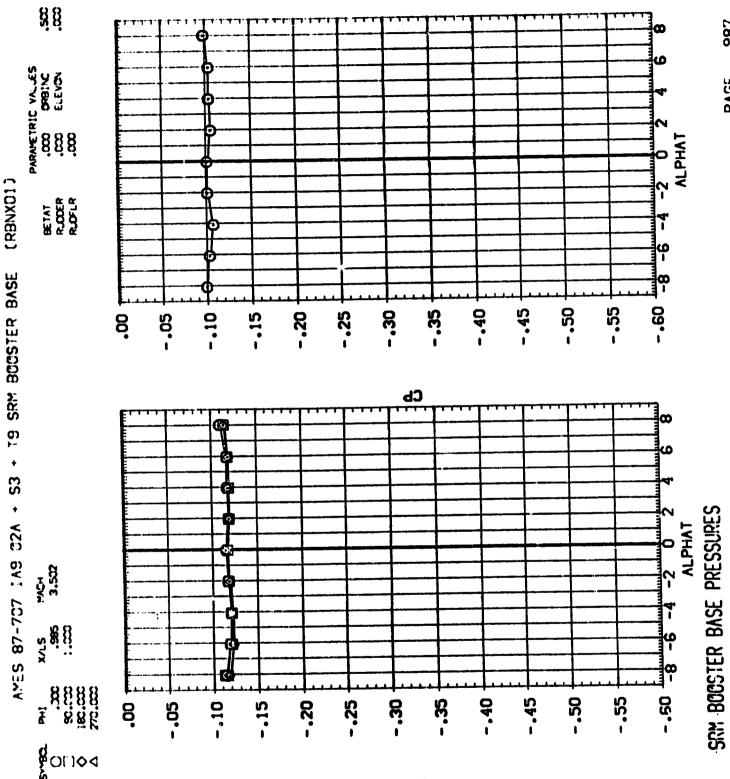
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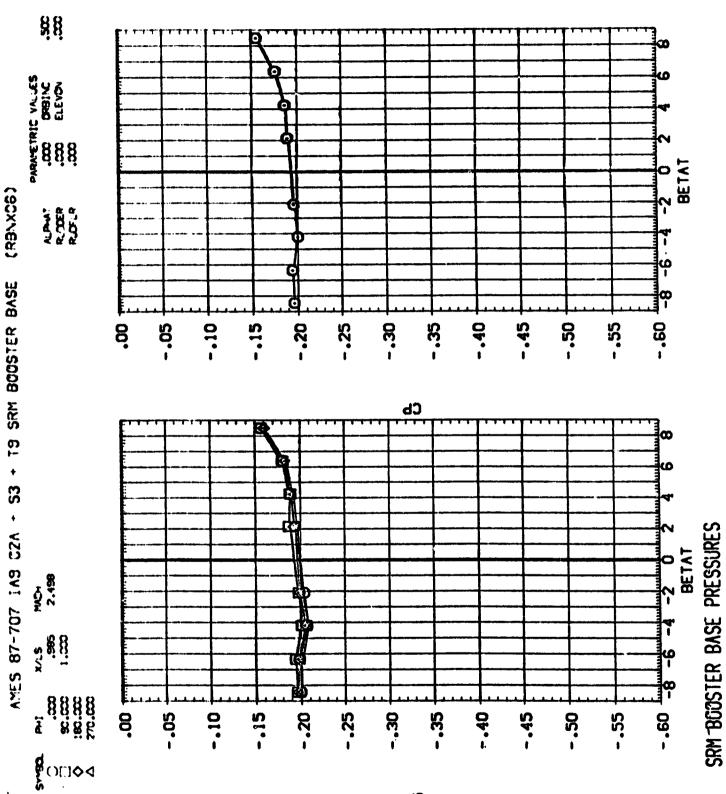
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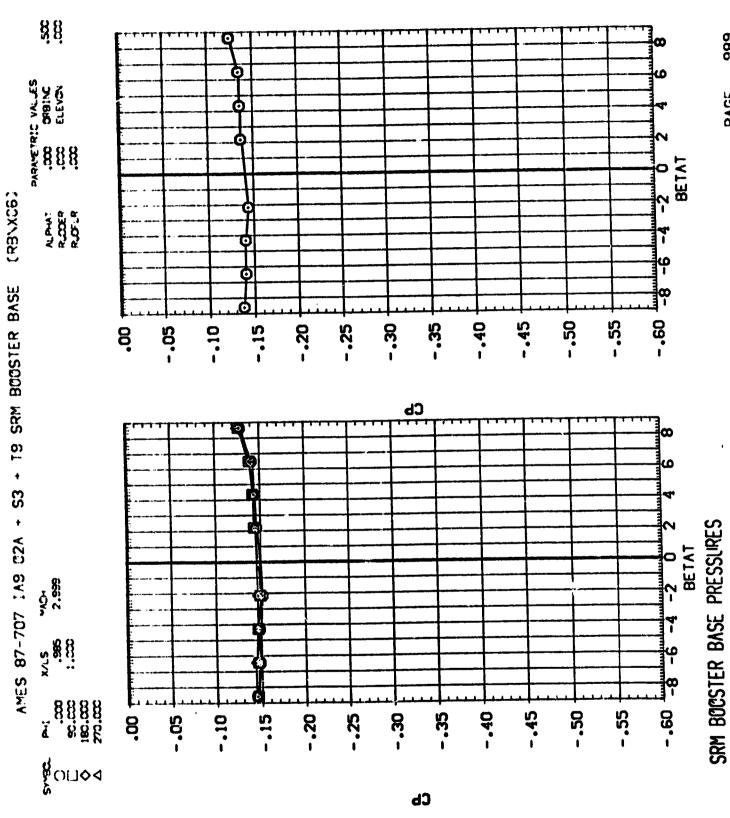


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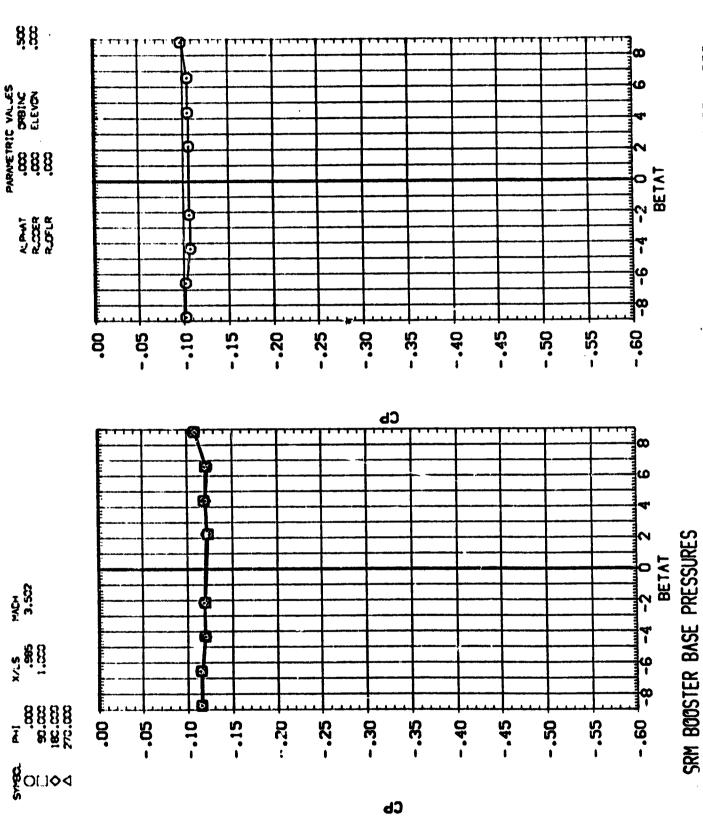
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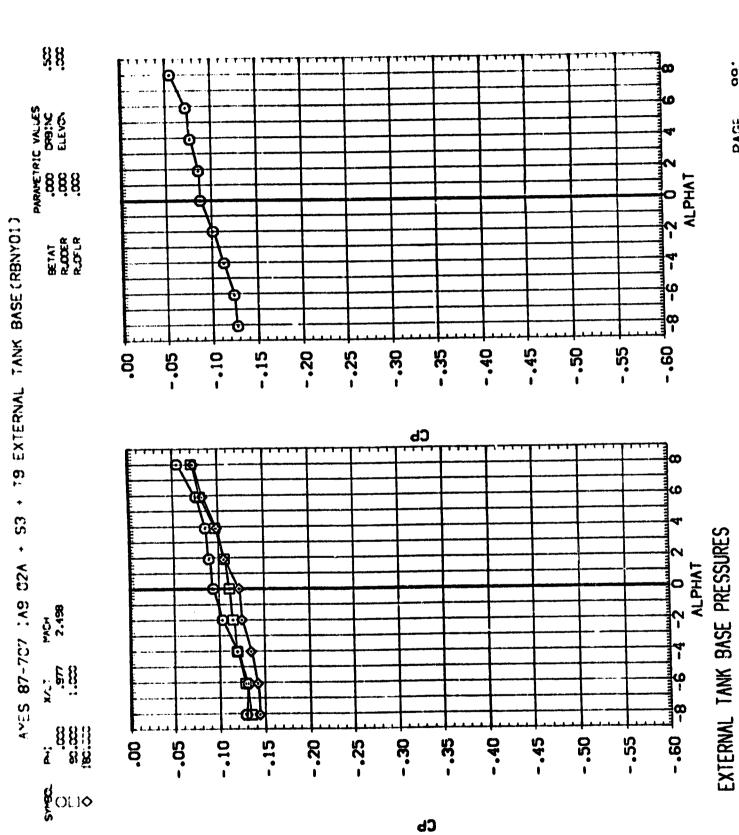
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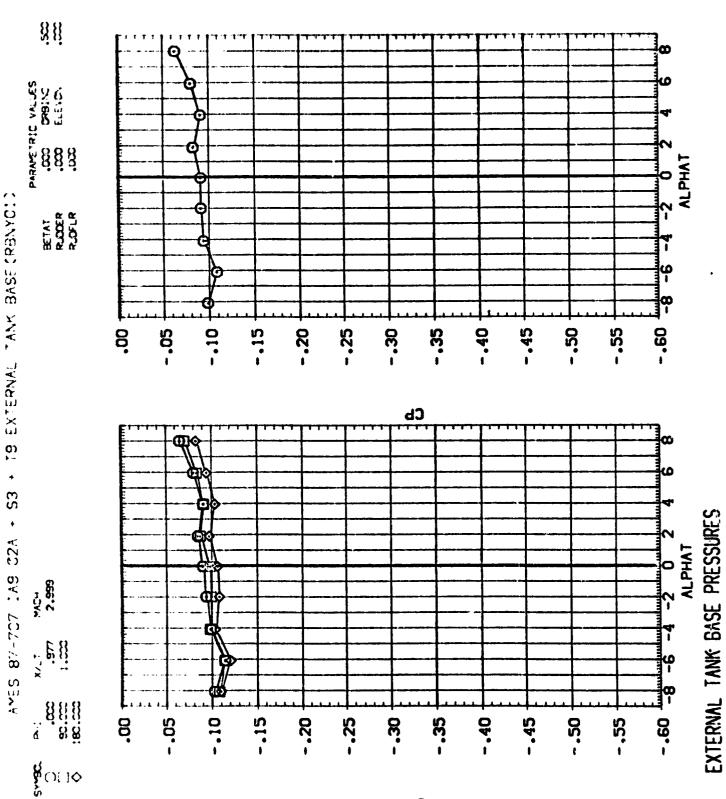


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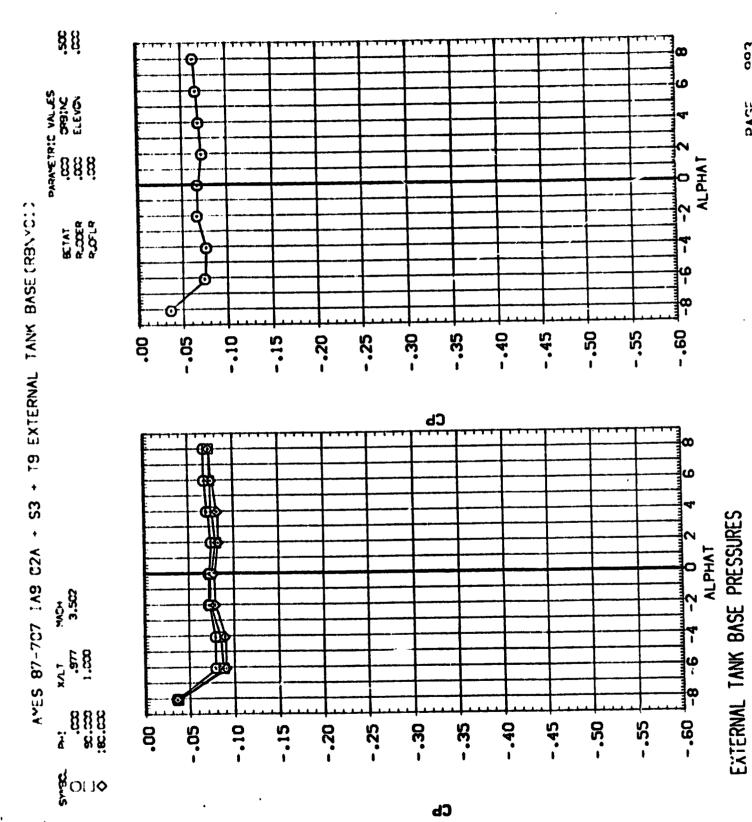
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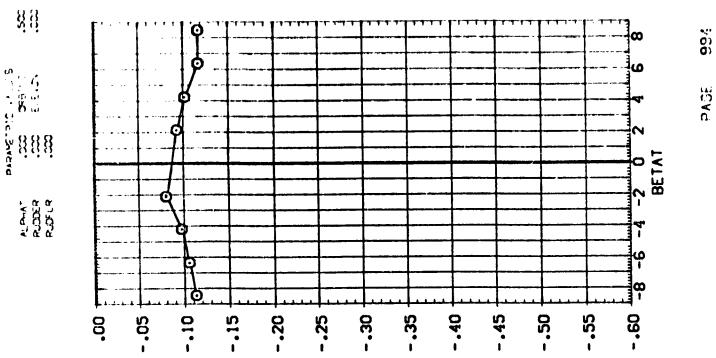


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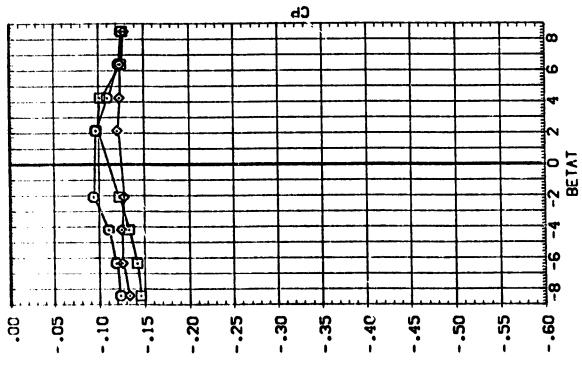




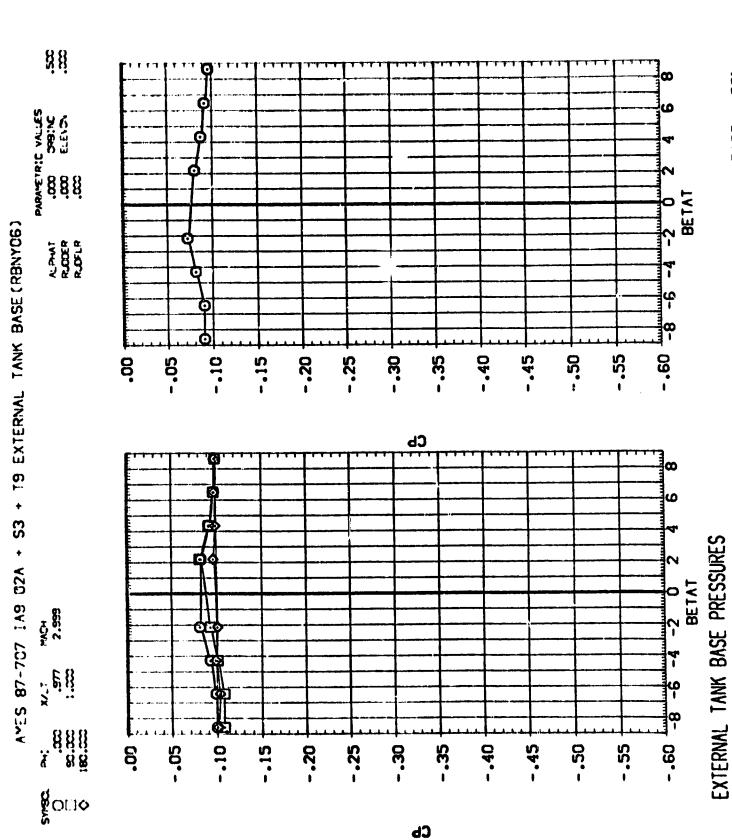
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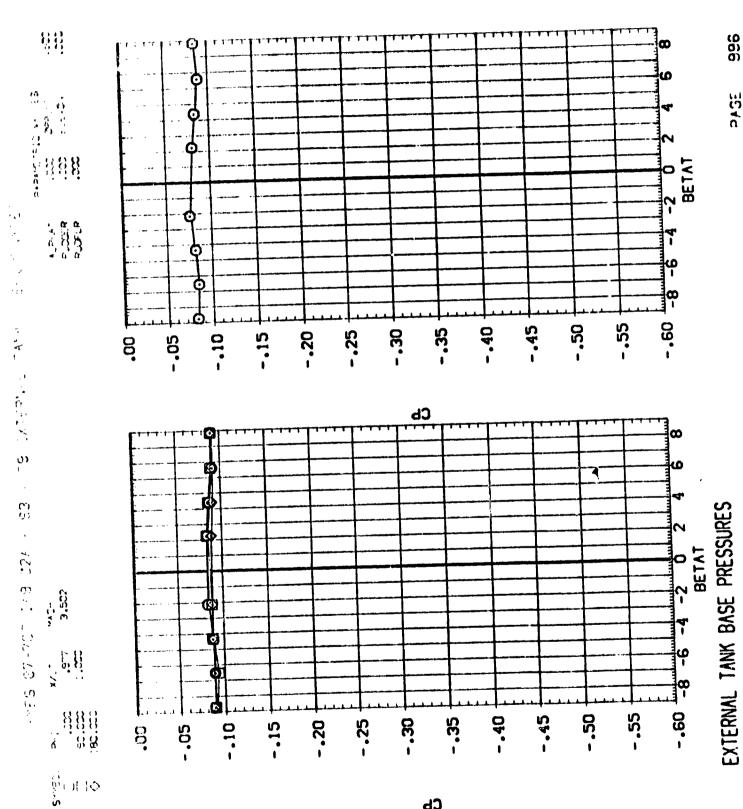
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